DECEMBER 1961

Heating Piping & Air Conditioning

. . . for Consulting Engineers
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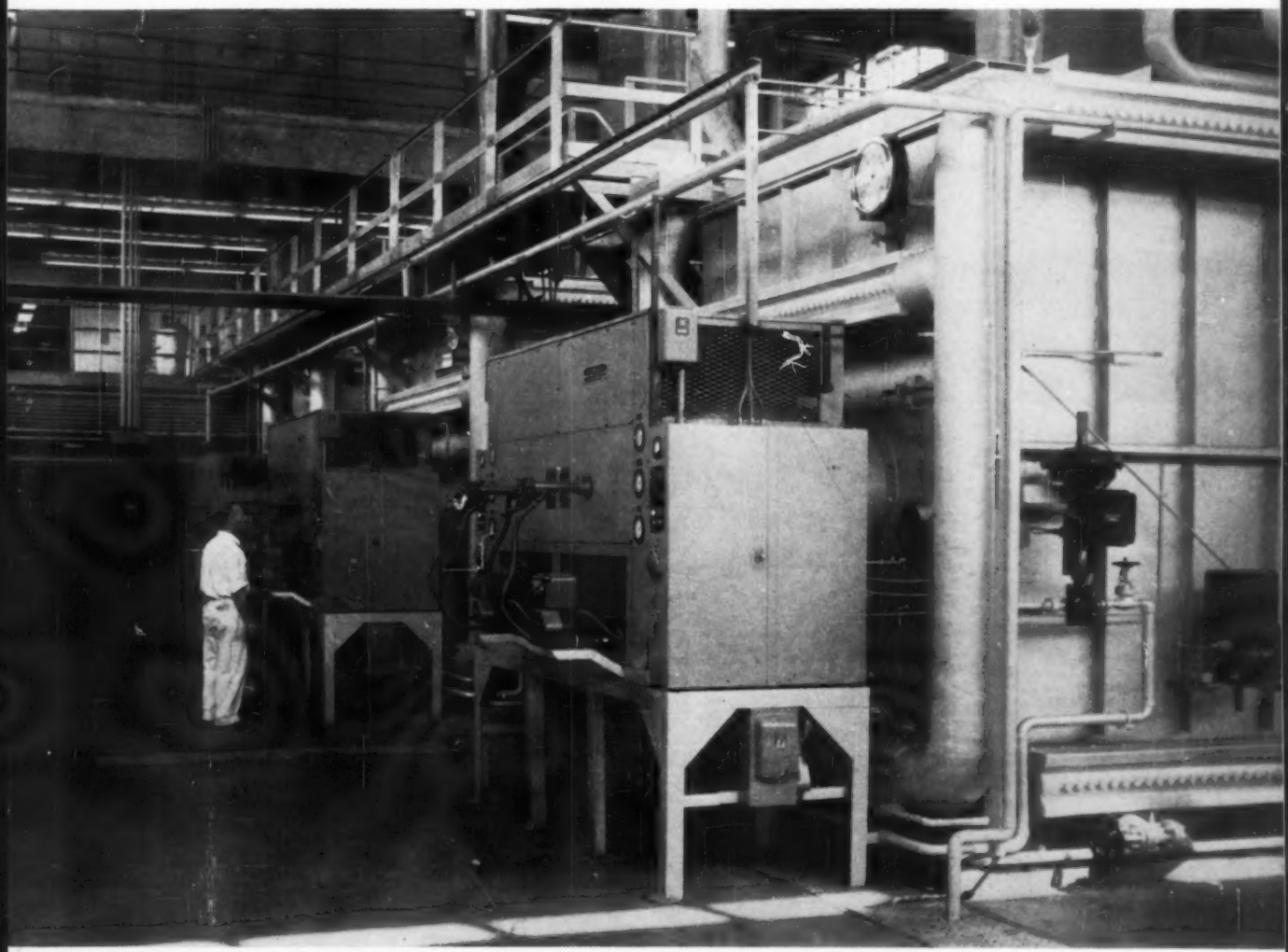

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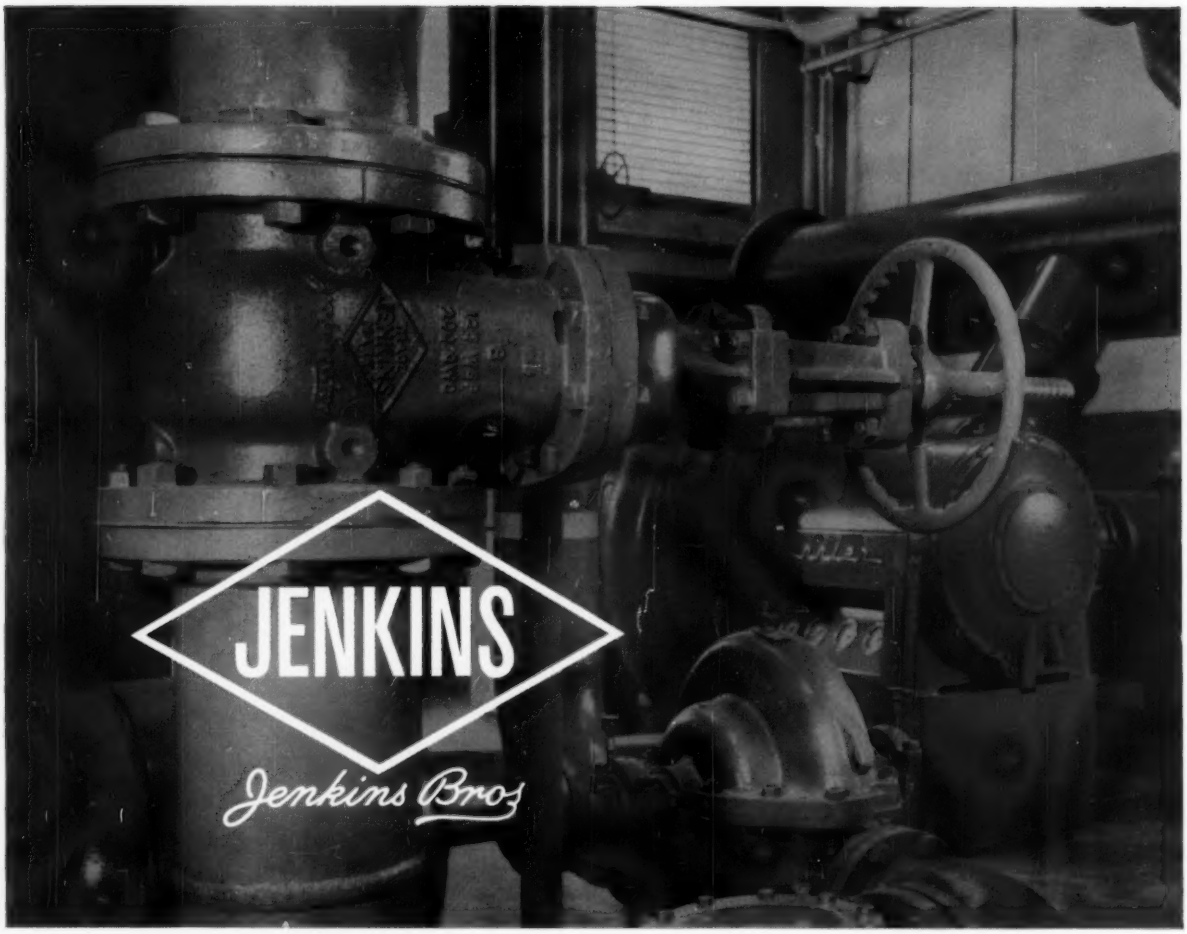

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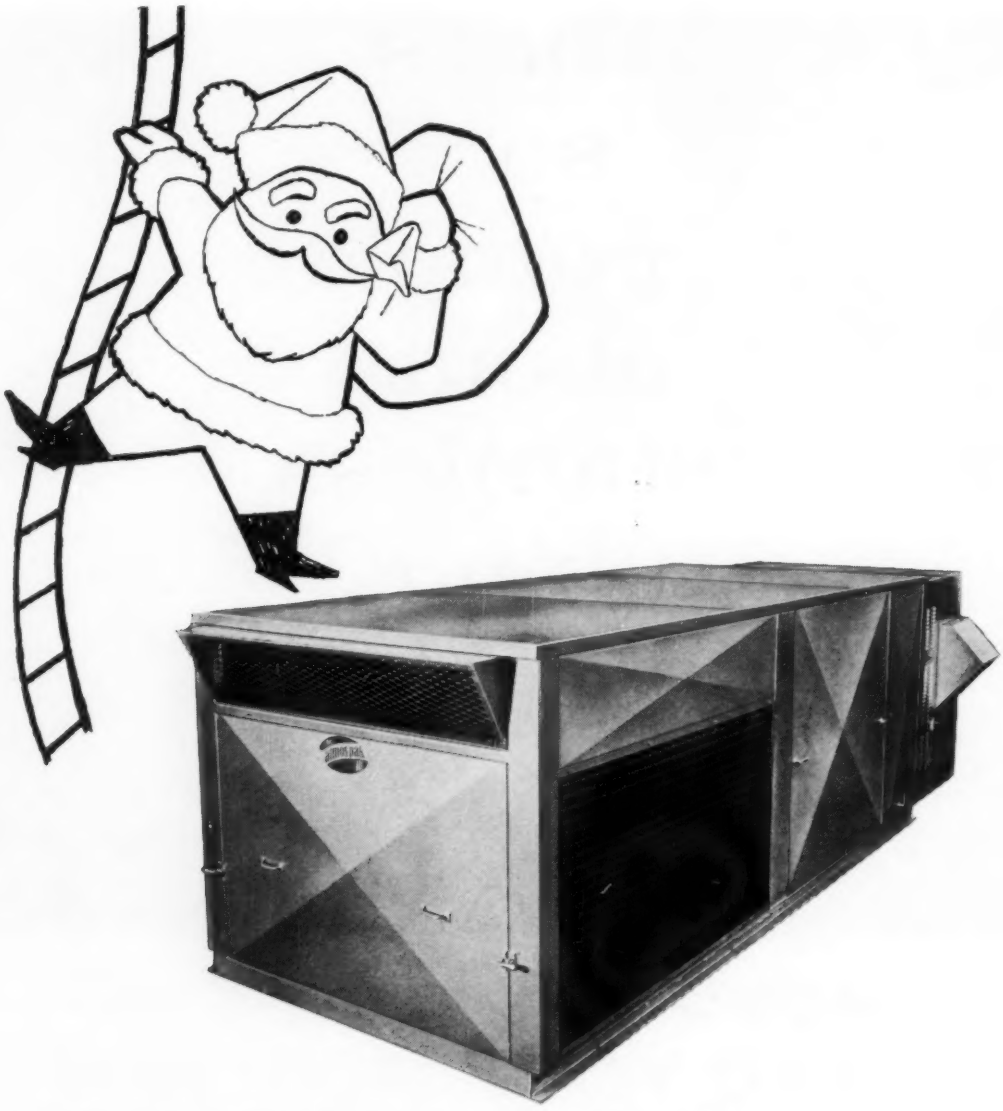

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Heating, Piping & Air Conditioning

FOR CONSULTING ENGINEERS, MECHANICAL (HPAC) CONTRACTORS, ENGINEERS WITH PLANTS AND BUILDINGS

VOL. 33, NO. 12 DECEMBER 1961

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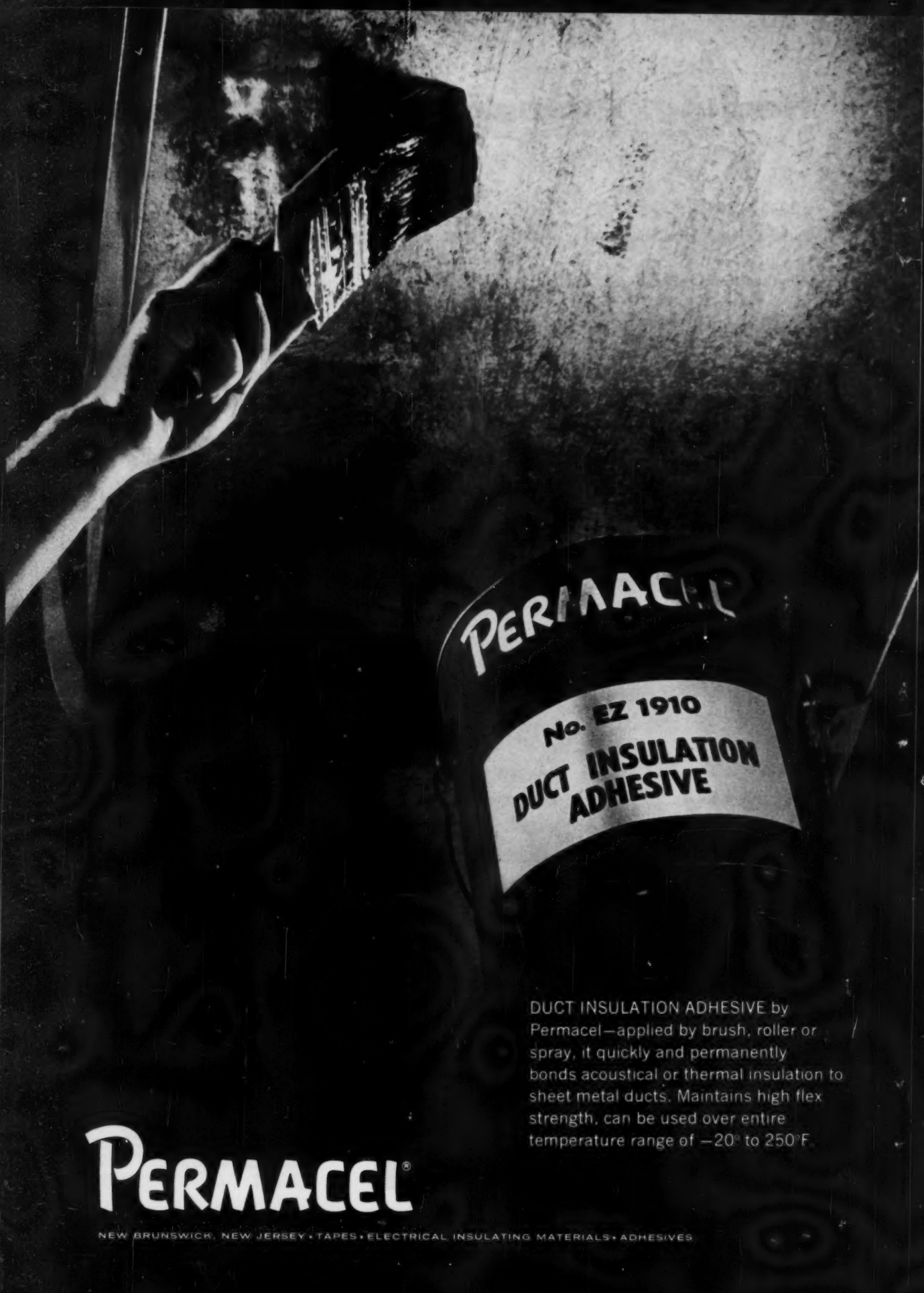

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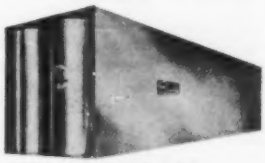
Fan Noise CONTROLLED in Air Handling Systems QUICKLY & ACCURATELY in less than 5 minutes!

Recognition that noise generated by fans in air handling systems could be predicted and controlled has led to a series of developments in both the "calculations" and also the necessary noise control equipment.

Guesstimating has now been eliminated by the general acceptance of these 4 important steps, functions and/or considerations: (1) that the total fan noise and its spectrum is substantially per the ASHRAE GUIDE dated 1957 or later (2) that we now have workable data covering the natural noise reduction due to ductwork, elbows, splits, distances, end reflections, room absorptions, etc. (3) that we have NC and NCA criteria for each of the 8 octave bands for most types of areas and we can now specify what is desired, and more important, by using an octave band analyzer, it can be readily determined whether the specified criteria has or has not been met (4) the development of prefabricated noise reduction units (noise traps, sound traps, etc) which have been properly factory tested and rated so they can be used with the method mentioned above.

"Short Form" Makes Selection Easy

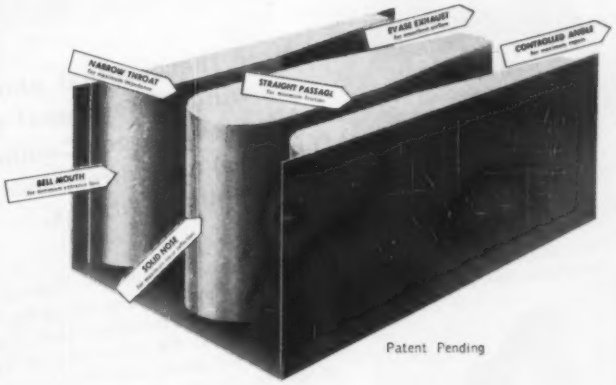
Since that time, because of the progress made in the design of Quiet-DUCT Silencers, and the wide acceptance of newly developed techniques mentioned above, the "Short Form" has been developed to make the selection of unit silencers for air handling systems an easy matter.



QUIET-DUCT SILENCERS
4 STANDARD MODELS
4 LOW PRESSURE MODELS
44 UNIT SIZES
90 MULTIPLE UNIT SIZES

CONIC-FLOW SILENCERS
18 STANDARD UNIT SIZES

"Cut-Away" View Reveals New Design of "Packaged" Quiet-DUCT Silencers.

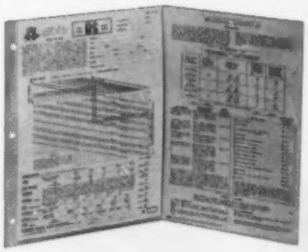


Patent Pending

Over ten years of experience in controlling noise in air handling systems has resulted in this new, basic design for all "packaged" silencers manufactured by our company. Design requirements include: *Bell Mouth Entrance* for minimum air pressure loss; *Solid Nose* for maximum noise reflection; *Narrow Throat* for maximum noise impedance. *Straight Passages* provide smoother airflow with more silencing and less regenerated noise. *Less Pressure Drop* is achieved by the diverging design of the evasè exhaust, keeping turbulence at a minimum and attaining maximum pressure regain.

The "SHORT FORM" consists of a small binder containing a pad of 25 reproducible work sheets. Only one such sheet is necessary to quickly and accurately resolve each noise problem and determine whether silencers are required, and if so, the silencer model needed to provide the Noise Reduction required for the problem. The "SHORT FORM" gives the Noise Reduction required in the 3rd octave band (in decibels) based on the data and procedures published in the ASHRAE GUIDE & DATA BOOK. Many field experiences have demonstrated that 3rd band calculations, by themselves, are a reliable index to silencing requirements as related to air handling systems. Because of the inherent characteristics of the "packaged" Quiet-DUCT silencers — if silencing is required in the 3rd Band, and the unit silencer is selected based on this criteria, more than enough noise reduction will be provided for all other bands as well.

The "SHORT FORM" is available through our representatives or write direct.



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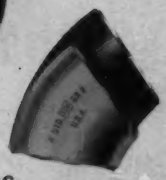
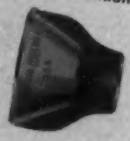
Compact 90° Elbow versus conventional long radius elbow*



Compact 45° Elbow versus conventional 45° elbow†

Compact Straight Tee versus conventional

Compact Reducing Tee versus conventional



Compact Concentric Reducer versus conventional

Compact Eccentric Reducer versus conventional

Compact Welding Cap versus conventional

Note these actual photos showing dimensional differences between Compact Fittings and corresponding conventional fittings.

*The Compact 90° elbow is contrasted with a conventional long radius elbow which is by far the most commonly used type. Of course the dimensions of the Compact 90° elbow are the same as those of regular short radius Taylor Forge WeldELLS.

†The 45° conventional elbow has heretofore been obtainable only in the long radius pattern shown in the comparison.

Tests prove rugged strength

Photograph shows a test that has proved the rugged strength of Compact Line Fittings. The test unit was fabricated from 4" and 6" Standard Thickness (Schedule 40) Grade B pipe and includes a 6" x 6" x 6" Tee, a 6" 90° Elbow, a 6" 45° Elbow and a 6" x 4" Concentric Reducer.

In testing, a mean pressure of 875 psig (five times WOG rating) was established as basic pressure. Cyclic pressure variation was from 50% under to 50% over this pressure—in other words, from 437 psig to 1312 psig. The assembly was then subjected to 36,500 of these pressure cycles—the equivalent of one cycle per day for *100 years!*

Upon completion of the cyclic testing, the unit was hydrostatically burst, the break occurring, as it theoretically should, in the crotch of the tee and extending into the adjacent run and branch pipes. Moreover, the unit had to be brought to a pressure of 5200 psig before bursting, yet the theoretical bursting pressure of 6" pipe is only 5080 psig. After 36,500 pressure cycles this result is rather startling.

90° ELBOWS

45° ELBOWS

STRAIGHT TEES

it's the New TAYLOR FORGE

there IS a way

to cut heating/cooling piping costs and still have a piping job you can be proud of

Yes, the new Taylor Forge Compact Line of welding fittings really does reduce piping costs. First, because the simplified designs and reduced dimensions permit major manufacturing economies. Second, because all other incidental costs—shipping, storage, trucking, on-the-job handling—are also less than with conventional fittings.

Take the 4″ size for example: A "set" of Compact Fittings consisting of a 90° and 45° elbow, straight tee, cap, 4″ x 2″ tee, 4″ x 2″ concentric reducer and 4″ x 2″ eccentric reducer exactly as illustrated here, weighs little more than half as much as corresponding conventional fittings. And remember, this weight savings is purely the result of designing and dimensioning functionally for economy.

Taylor Forge Compact Line Fittings give you a piping job you can be proud of, too. Proud of its trim functional appearance. Proud of its rugged strength and complete dependability—well supported by the test described on the opposite page.

Compact Line Fittings are of seamless construction using Grade B carbon steel. The line includes 90° and 45° elbows, straight and reducing tees, concentric and eccentric reducers and caps in sizes 2″, 2½″, 3″, 4″, 5″ and 6″; reducing tees and reducers in intermediate iron pipe sizes down to one-half of the nominal run or large end size. They are manufactured to the same high standards as other Taylor Forge products for piping and pressure vessel construction. All have complete stamped-in identification markings as shown. For protection, identification, and pleasing appearance, they are painted orange with non-toxic corrosion resistant paint.

American-made Welding Fittings

Designed and manufactured for utmost economy. No frills; just the solid value you would expect from TAYLOR FORGE.

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TRADITIONALLY DEPENDABLE

Compact line fittings are carried in stock by Taylor Forge Distributors in all important trading centers. The whole story is in Bulletin 619. *Ask for it.*

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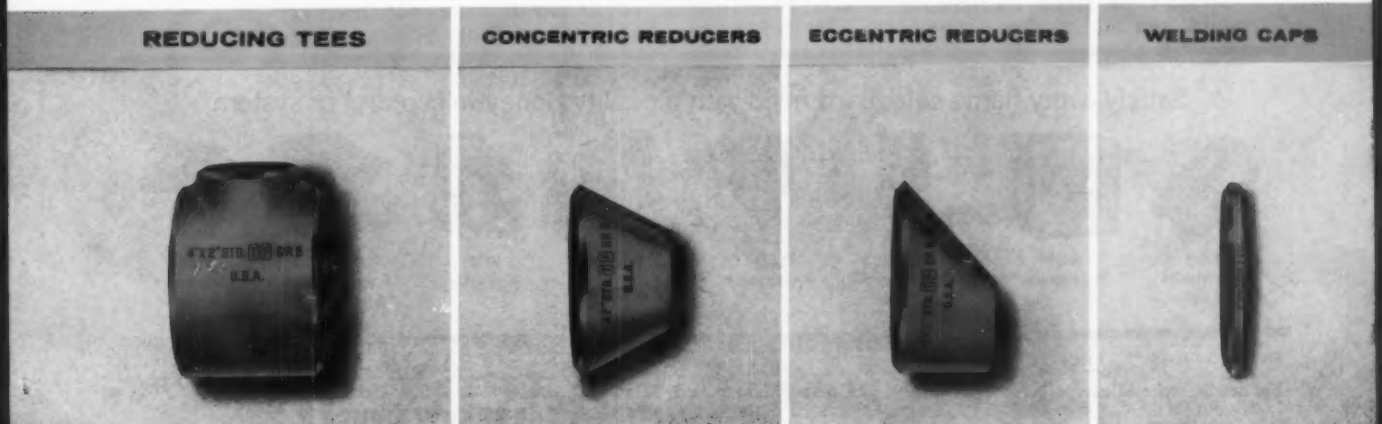

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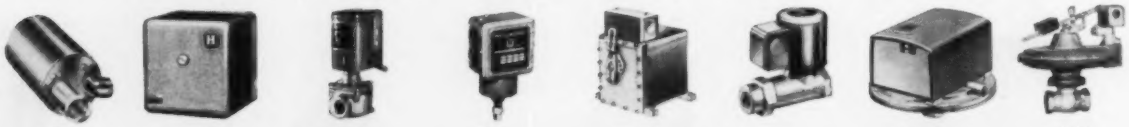

C7012 Ultra-Vision* Flame Detector | RA890 Protectorelay* | V4034 Fluid Power Gas Valve | L404 Pressuretrol* | M931 Modutrol* Motor | V4021 Oil Valve | C645 Pressure Switch | V4004 Diaphragm Gas Valve

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LETTER FROM THE EDITOR

December 1961

Dear Reader:

An excellent article on the engineering reasoning why a high temperature hot water heating system was selected for the world's largest aircraft engineering and maintenance base in Montreal is given on page 85. You have seen this article featured on the cover, and it is certainly worthy of your attention, in my opinion. Harald Tamm, the author, explains why nitrogen pressurization was chosen, for example, and how the temperature differentials were determined for this large job, plus many other valuable points. The balance of the system by means of orifices in the lines was very critical, as can be readily understood because both friction loss and shock loss had to be considered.

Does it always pay to insulate pipe flanges? William Gross answers this in his article on page 93 by saying it does always pay to consider the question even though the answer may be negative sometimes. The economic factors that should be considered in reaching this decision include the length of time the system will be in use, the heat loss from the flange area, and also the possible danger involved in leaving the flanges exposed. Mr. Gross presents graphs showing fuel savings that may be experienced with insulated flanges in different sizes and for two steam conditions. This analysis and the data shown should serve as a good guide for you on this subject.

Computer installations and their complex control systems have been receiving a lot of attention recently from the viewpoint of maintaining precise environmental conditions in the space they are located. In the article on page 96, Philip A. Green explains a system design for such a computer installation which handles both equipment cooling and at the same time provides the desired comfort in the space with a unique "constant pressure" device.

What's the significance of ions in the air? The report of a recent conference on this subject is presented on page 100. This is a good summary of what ionization is, what happens to the ions in a room, what effects they cause, and what is coming in the future on this subject.

The engineers have chosen to combine a perimeter dual-duct system with a unique integrated lighting and air conditioning system for the inside areas in the new Los Angeles Water and Power office building. C. S. Perkins explains why this has been done and how these systems have been designed in his article on page 103. The return air is used to temper high velocity cold air in specially designed single-duct induction boxes. This analysis of loads and how it was decided to control the indoor environment of this large office building is a good example of how present-day engineering is being applied to keep abreast of the architectural developments in large glass-skinned buildings.

To control the right amount of supply and exhaust air in commercial kitchens, A. M. Hagler has developed a compact control system which he explains on page 108. An automatically controlled variable voltage regulator controls the speed of the motors on the supply and exhaust fans so they perform in unison. Thus, the capacity of the system is regulated in accordance with room air temperature, outdoor temperature, and the operation of the heat-producing equipment in the kitchen.

We have all heard much about school air conditioning, but we have not had an opportunity before this to study the subject as deeply as Maurice J. Wilson has presented it in his article on page 112. This practical discussion of school climate control and system selection is worthy of your study and future reference. Mr. Wilson includes a table which is a functional evaluation of heating, air conditioning, and ventilating systems for schools as determined by a panel of engineers which is very valuable, in my opinion.

The problem of eliminating noise and vibration in heating, piping, and air conditioning systems is a constant one, and its importance is growing steadily. Robert Swenson explains in his article on page 118 how and when flexible rubber connectors can aid in reducing this noise and vibration. He includes a number of tips that should also be helpful to you.

You can get the most from your central -- relatively low pressure -- plenum air conditioning system if it is properly designed with adequate controls, according to F. F. Stevenson in his article on page 123. He explains the function of the "economizer" plenum and the proper location and operation of the dampers, coils, instrumentation, and controls in order to achieve the best results.

Net positive suction head -- what it is, what it means, and how to include it in your calculations when selecting centrifugal pumps is the subject of the article on page 129 by Harold Woodhouse. This is a valuable discussion of a very important variable that should be considered in the selection of centrifugal pumps. Mr. Woodhouse has also included a number of practical examples to illustrate the use of this fundamental. This article is the final one in the series of three dealing with the many factors which should be considered in selecting the right pump for the right job.

Don't miss the news, notes, and other short items in the You'll Want To Know pages (37 to 40). "Open For Discussion" pages are on 73 to 78, and the HPAC Data Sheet (page 137) contains more tables for calculating weights of sheet metal ducts.

Bob Roose

Editor

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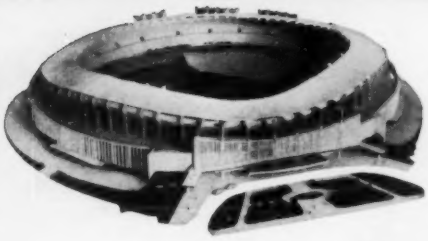


Circular stadium is full of angles

. . . and Bethlehem Steel Pipe was "rolled" through dozens of them

From start to finish, the new District of Columbia Stadium in Washington was built to please the customers. From the radiant-heated seating section alongside the field, to the cantilevered roof sheltering most of the 50,000 column-free seats, spectator comfort was the designer's aim.

28 water fountains are located around the stadium. Food and drink concessions—each with its own sink and drain—occupy some 800 linear ft along the walkways. And the 45 public rest rooms are equipped with an average of over 20 fixtures each.

A unique piping challenge

Piping the stadium was a job unlike any other. To start off with, the stadium is round, like the plan view of a doughnut with a 700-ft OD. It was built in 66 sections, each resembling a 5-level, truncated "pie"-shape with its side lines radiating from a point in the middle of the playing field. The upper levels are cut through by 66 huge, sloping cantilever beams, joined together with great box struts and wide-flange beams. Because of the undulating roof line, the position of this steelwork changes from section to section. This, plus the variously located services, required that the piping be laid out individually for almost every level of every section.

Bethlehem 6-in. pipe "rolls" along under the ceiling—with the help of two 11½° fittings. The job required about one ft of steel hanger rod for every three ft of steel pipe. Some 18,500 ft in all.

"Roll 74°"

As a result, very little straight-line piping was possible. And the common elbows were all-too-often inadequate to handle the odd angles required. "Rolling" the pipe around obstructions, using combinations of the rare 11¼° and 22½° fittings, became the rule rather than the exception. Almost every field sketch (there were hundreds) bore several notations, such as "roll 74°", or "roll 28°."

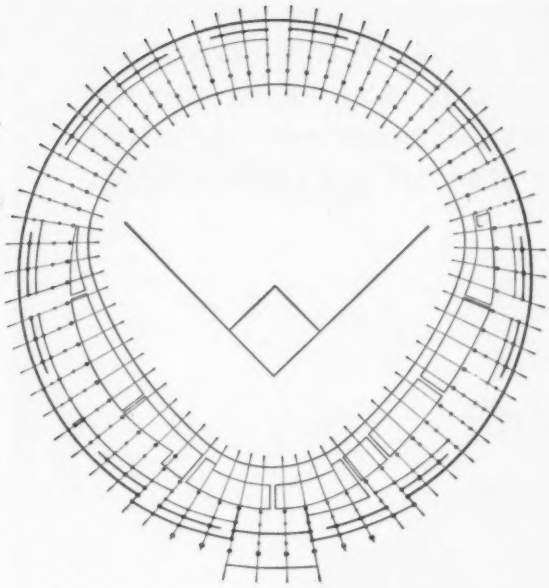
250 tons of steel pipe

The project includes thousands of feet of storm drainage lines, water supply lines, sanitary vents and waste lines, and lines supplying the heating and air-conditioning system. In all, over 61,000 ft of Bethlehem black and galvanized steel pipe were used, ranging in size from 1¼ in. in continuous buttweld, to 12 in. in electric resistance-weld.

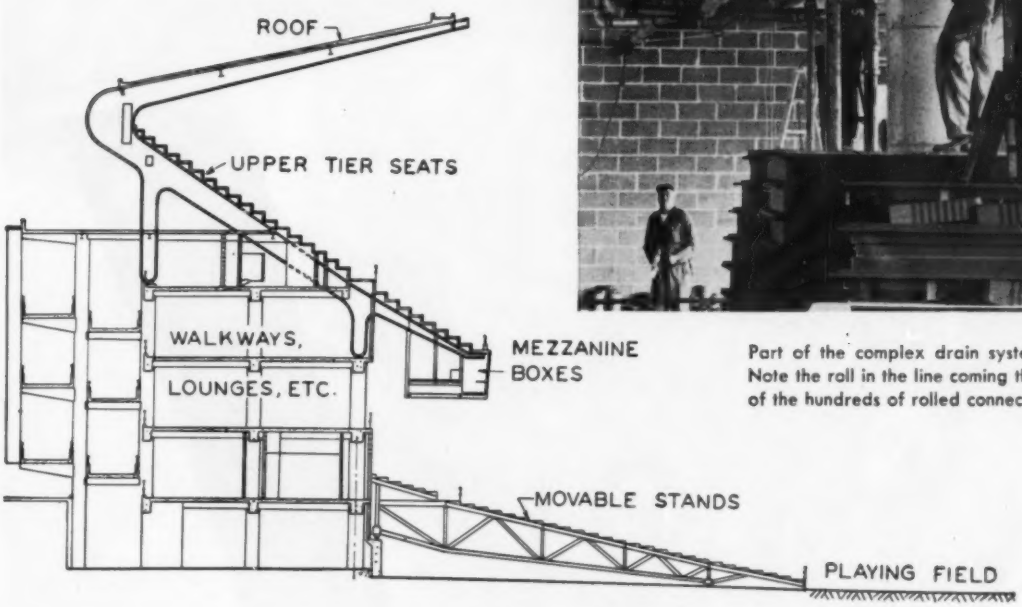
Owner: District of Columbia Armory Board
Architects and Engineers: Dahl-Erwin-Osborn
General Contractor: McCloskey & Co.
H, P, & AC Contractor: Lloyd E. Mitchell, Inc.
Pipe Distributor: Sanitary Supply Company, Inc.

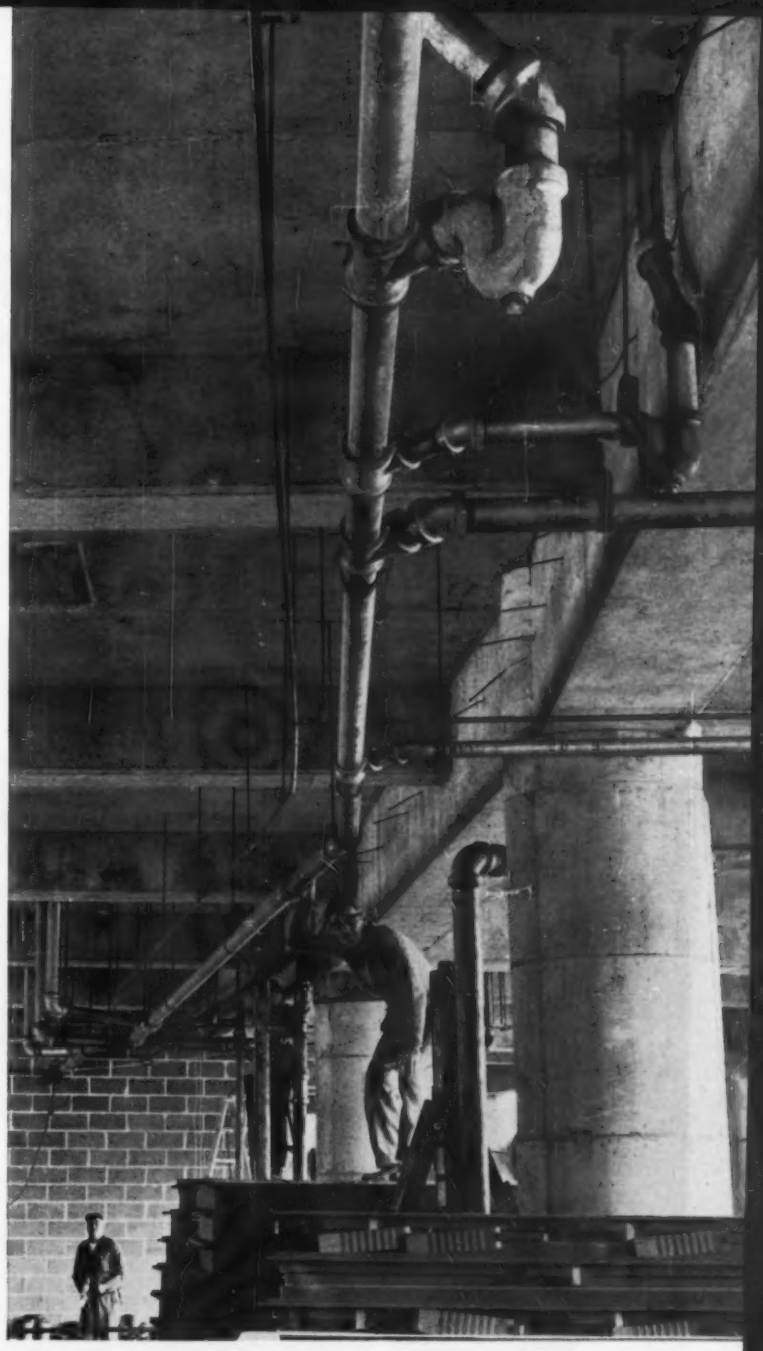
Insist on Steel Pipe Made in U.S.A.

BETHLEHEM STEEL



These simplified plan and section drawings clarify the stadium's novel design—and the problems which confronted the service contractors. Structurally, only 28 of the 66 sections, and no two of the six levels, are similar. Many of the services' layouts could be determined only at the job site.





Part of the complex drain system on the fourth level. Note the roll in the line coming through the ceiling—one of the hundreds of rolled connections necessary.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Steel

... for Strength
... Economy
... Versatility

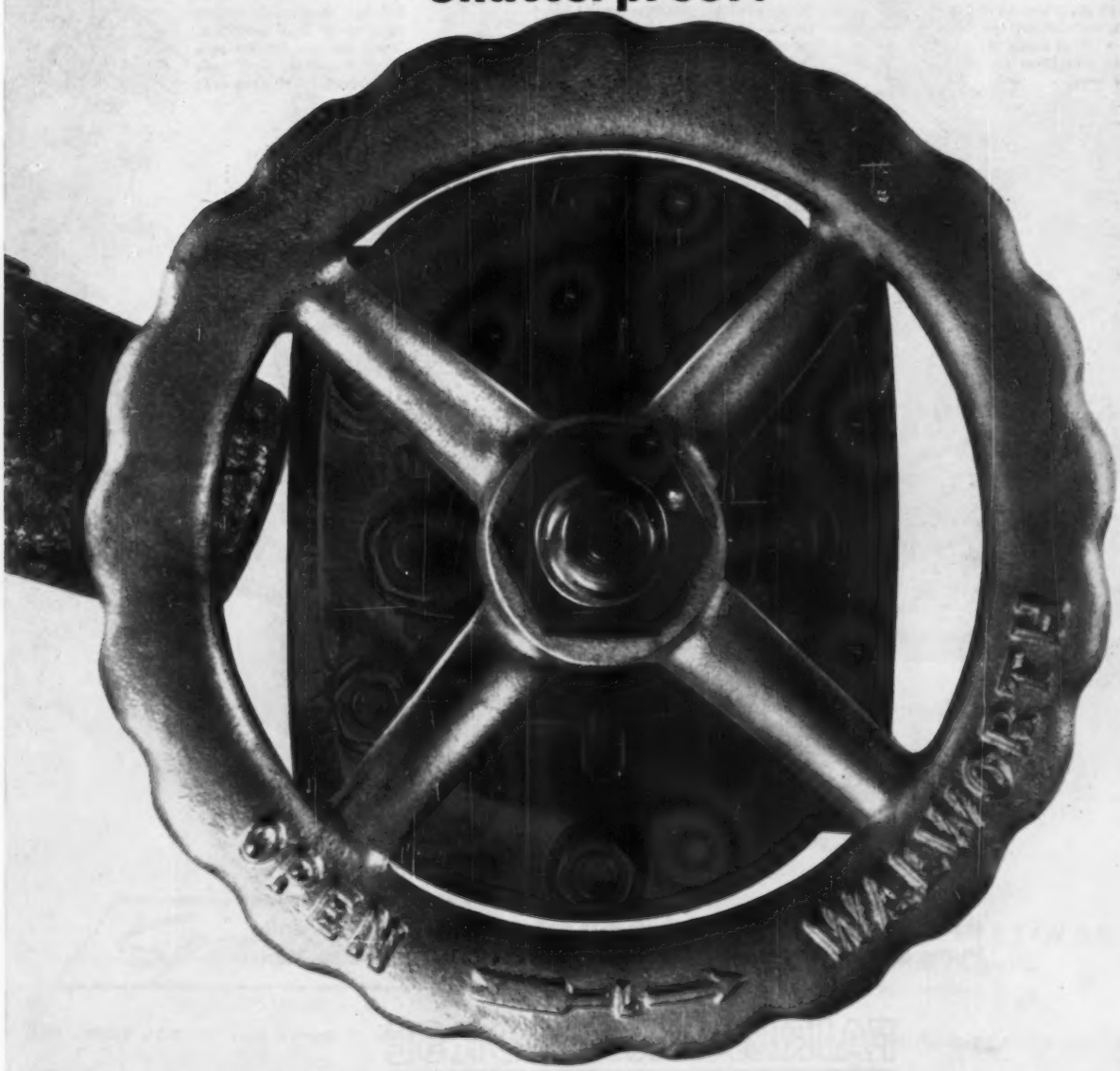
–that's WALWORTH DUCTILE IRON VALVES! Walworth's special* ductile iron alloy offers steel-like strength and toughness. That's why these valves are practically "shatterproof"–with exclusive Walworth Valve quality for good measure! ■ Think of WALWORTH DUCTILE IRON VALVES wherever your valves face unusual flexing conditions – and where economy is a consideration.

WALWORTH DUCTILE IRON VALVES are now available in gate, globe, check and angle types...2″-24″...in ASA 150 and 300 lb. classes. See your Walworth distributor, or write Walworth Company, 750 Third Ave., New York 17, N.Y.

WALWORTH

the Walworth companies: Alloy Steel Products Co. • Conoflow Corp. • Grove Valve & Regulator Co. • M&H Valve and Fittings Co.

Shatterproof!



*Walworth specifies minimum elongation of 18%

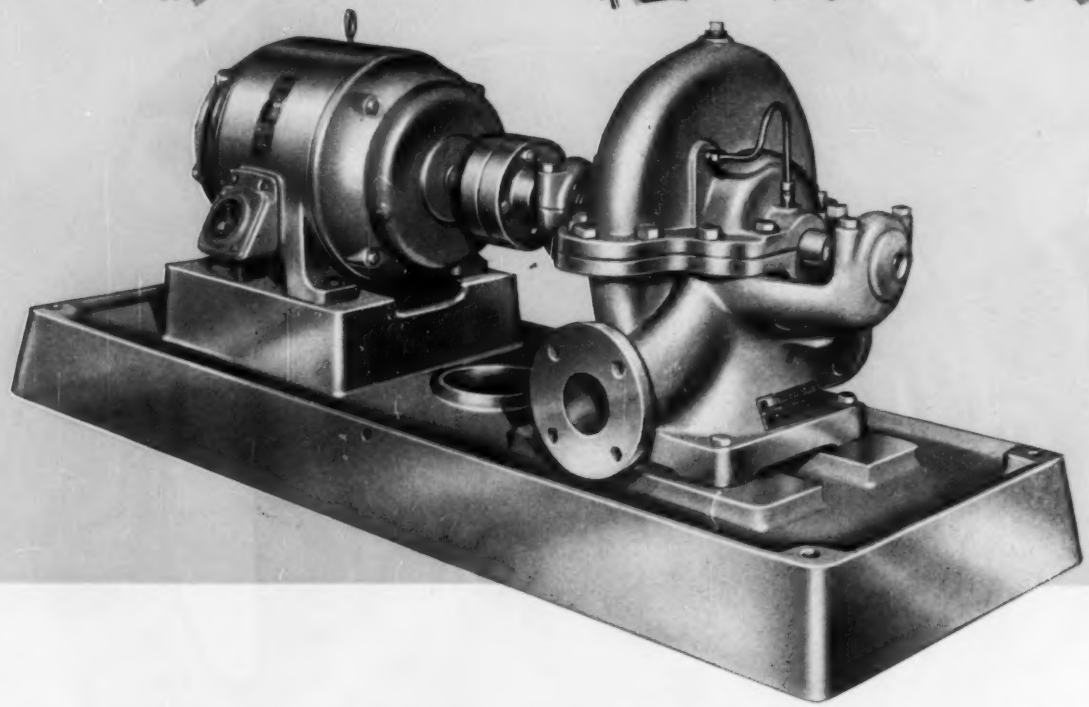
3 good reasons for specifying the NEW

Fairbanks Morse SPLIT CASE PUMP

1
CASING WEARING RINGS:
Maintain high pump efficiency, minimize recirculation past the impeller rim; rings easily replaced when waterborne particles cause wear.

2
MAINTENANCE-FREE OPERATION:
Sealed pre-lubricated bearings require no checking, no lubrication service.

3
SHAFT SEALS OR PACKING:
Optional construction, factory supplied or field conversion, to suit pumping requirements, either mechanical shaft seals or conventional ring-type packing.

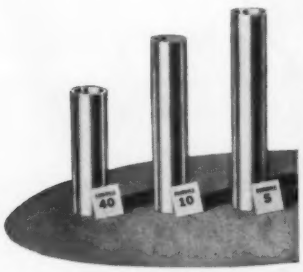


A brand new design . . . a brand new simplified concept in Split-Case Pumps. By far, your best buy. Single stage, horizontal Split-Case Centrifugal Pumps—a wise choice for chilled water, circulating or booster duty —cooling towers or general water supply, designed and supplied to you at moderate cost. For further information and factual bulletin #5820, write: **Pump & Hydraulic Div.; Fairbanks, Morse & Co.; Kansas City, Kan.**

FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY

REAL ECONOMY IN PROCESS PIPING IS A MATTER OF SPECIFICATIONS—AND SPEEDLINE FITTINGS!

Make the most of both. First, be sure to check ASA B31.3 for up-to-date pressure-temperature data on critical process applications. This most recent issue of the Code for Pressure Piping certifies the use of light-wall pipe and fittings to a degree not recognized by outdated specifications.



SPECIFY LIGHT-WALL PIPE and get up to 50% more pipe for your dollar

Next, consider the installation advantages of Speedline's improved fittings design to capitalize on light-wall piping savings. Note Speedline's "tangential feature" . . . the extra length of straight on every end of every Speedline Fitting. This extra clearance eliminates alignment problems and speeds welding . . . permits joints to be readily butt-welded, flanged, or socket-welded. You choose the most practical, cost-saving joining method for your application—and one fitting can be used all ways when you specify Speedline Fittings.

Compute total savings in terms of initial costs *and* ultimate *installed* costs. Light-wall pipe and fittings, of course, cost less to begin with because they use less metal. Speedline versatility, however, adds *extra* savings in installation time and labor costs that further reduce final installed costs.

SPECIFY SPEEDLINE FITTINGS and reduce installed piping costs to a minimum

Piping standards have changed. It will pay you to be up-to-date with light-wall specifications that call for Speedline Fittings. Get details from your nearby Speedline Distributor today. He's listed on page 1494 of Chemical Engineering Catalog.

Speedline®

CORROSION-RESISTANT FITTINGS

STAINLESS STEEL • ALUMINUM • NICKEL

OTHER ALLOYS ON APPLICATION

300

A PRODUCT OF **HORACE T. POTTS COMPANY** • 376 E. ERIE AVENUE, PHILADELPHIA 34, PA.

Lock seaming ceases to be a problem when you use Weirkote® Zinc-Coated Steel. This modern continuous-process tightly bonded zinc-coated steel won't peel, chip or flake. Work it to the limits of the steel base itself and the zinc coating remains intact assuring you of the complete corrosion protection that only zinc can give. A representative will be happy to supply more complete information on Weirkote—another fine product of both Weirton Steel and Midwest Steel.

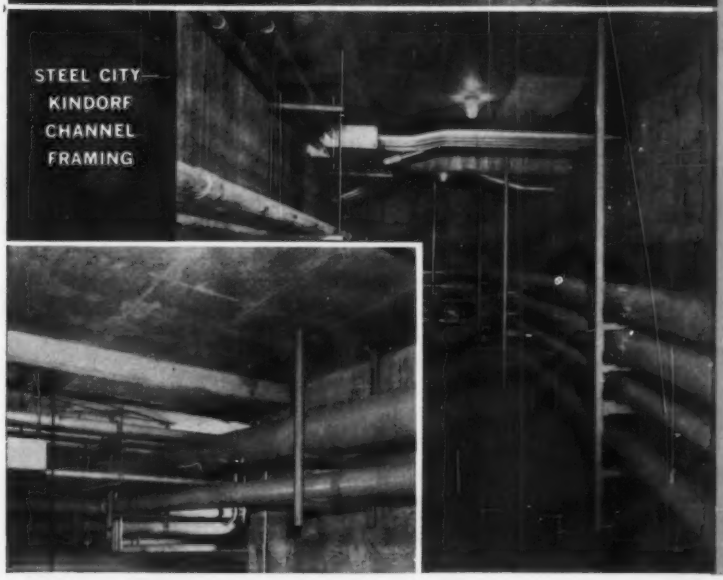
MIDWEST STEEL
Portage, Indiana

WEIRTON STEEL
Weirton, West Virginia

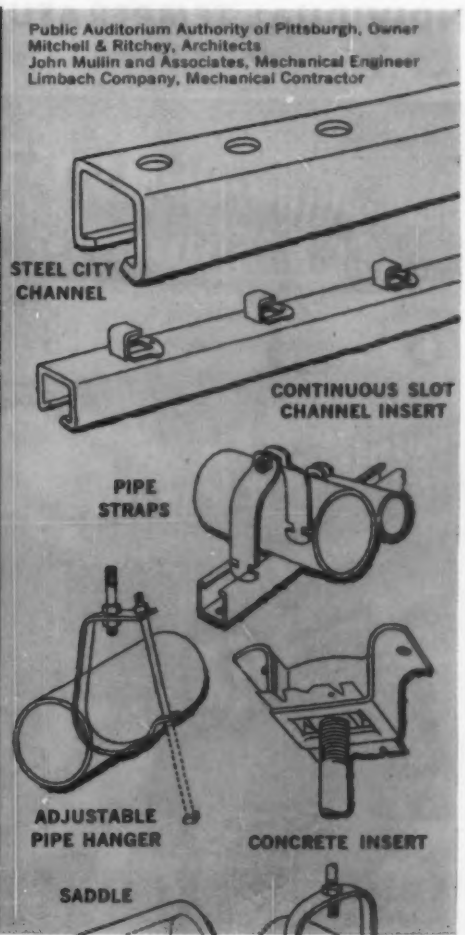
divisions of
NATIONAL STEEL CORPORATION

All-Around Performer at the Civic Arena...

WHERE NEARLY EVERYTHING BUT THE RETRACTABLE ROOF HANGS FROM STEEL CITY CHANNELS



Public Auditorium Authority of Pittsburgh, Owner
Mitchell & Ritchey, Architects
John Mullin and Associates, Mechanical Engineer
Limbach Company, Mechanical Contractor



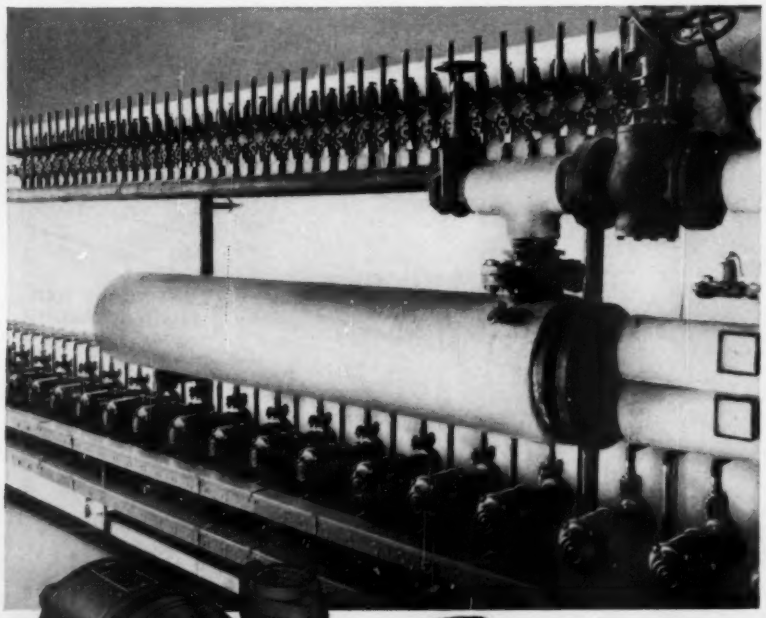
Heating, ventilating and air conditioning systems throughout Pittsburgh's new Civic Arena are supported by Steel City's Kindorf system of channels and accessories.

There's a Steel City Channel for every piping application and a wide variety of fittings for every type of installation. Write for informative handbook.

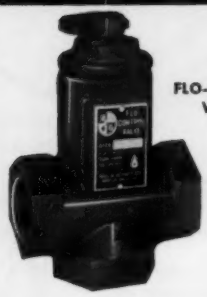
STEEL CITY ELECTRIC COMPANY PITTSBURGH 33, PA.

Subsidiary of Martin-Marietta Corp.

NEAR THE ARCTIC CIRCLE 40 B&G BOOSTERS GIVE RESIDENTS INDIVIDUAL TEMPERATURE CONTROL



B&G BOOSTER



B&G FLO-CONTROL VALVE

At Fairbanks, Alaska, tenants in the Anderson Apartments enjoy all the comforts of *radiant Hydro-Flo* heating plus their own choice of temperature. Each apartment is on a separate heating zone and has an individual thermostat to control the operation of a B&G Booster pump. In each circuit, a B&G Flo-Control Valve prevents the possibility of an over-ride in heat.

A 2-pass B&G steam-to-water converter provides hot water for the heating system.

B&G Boosters are designed and built specifically to meet the exacting demands of circulated water heating and cooling systems. Their freedom from maintenance problems as well as quietness of operation explain why B&G Boosters are the preferred pumps.

THE BUILDING:
Anderson Apartments, Fairbanks, Alaska

ARCHITECT:
Phileo Engineering Co.

HEATING ENGINEER:
Fairbanks Plumbing and Heating

PLUMBING AND HEATING:
Fairbanks Plumbing and Heating

GENERAL CONTRACTOR:
Kenneth P. Anderson, Contractor

The B&G Booster is engineered for compactness, *silent operation* and years of service. It is built by precision manufacturing methods which translate good design into a superior product. Over 3,500,000 have been installed to date.

The B&G Flo-Control Valve is so designed that it can be easily cleaned without removing it from the pipe line.

BELL & GOSSETT
COMPANY
Dept. GX-5, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

How Empire State Building and American Airlines solved vital fire protection problems with EVERLASTING VALVES

102 stories, 1,472 feet high, 16,000 tenants and 35,000 visitors sum up the fire protection problem of the Empire State Building. An in-building fire protection system is necessary to an unfailing water supply.

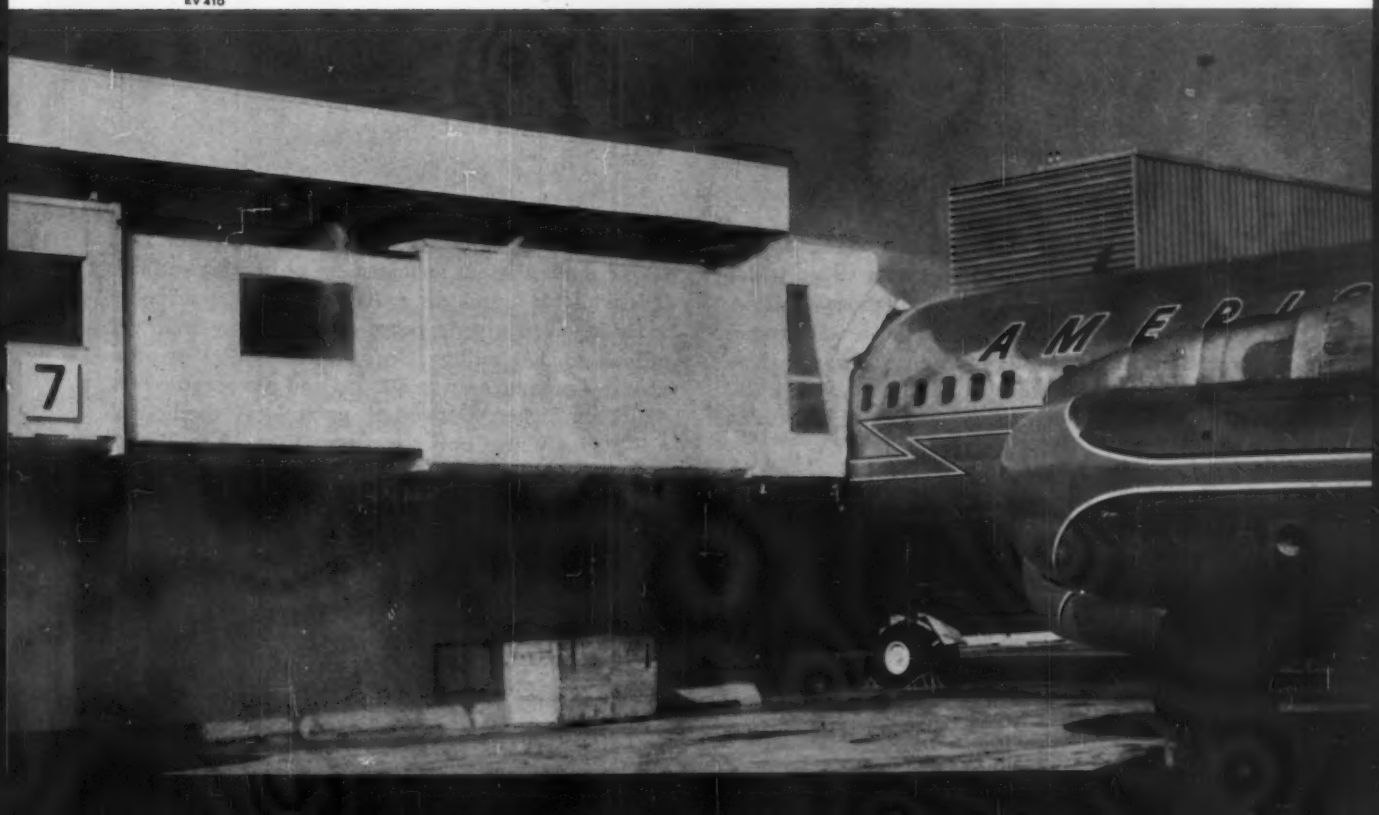
American Airlines loading bridge, shown below, gives passengers positive protection against fire with a unique deluge system.

Both these fire protection systems depend on Everlasting Pendulum Stop Valves, which have been installed in thousands of critical fire protection systems over the past 35 years.

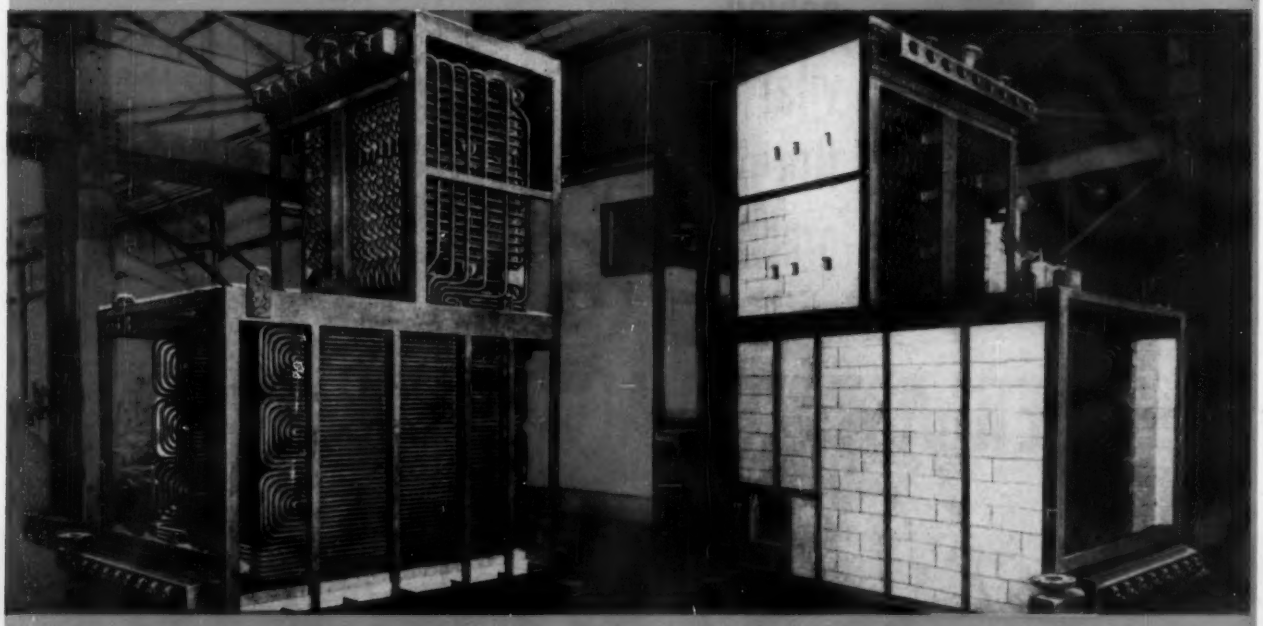
For complete information on the unique American Airlines and Empire State Building systems, write for bulletins F. They include an editorial description of both these installations and a bulletin describing Everlasting's positive action pendulum stop valves.

Everlasting also makes a line of quick-opening valves for general service, boiler blow-off, and handling viscous materials, as well as a line of cylinder-operated valves. Bulletins on all these valves are available. **Everlasting Valve Company, 61 Fisk Street, Jersey City 5, New Jersey.**

EV 410



for space heating... or process heat... investigate the ECONOMY and EFFICIENCY of C-E HIGH TEMPERATURE



1 Shop assembly of 12-million Btu C-E High Temperature Water Boiler. Shows steel frame and pressure parts.

2 Same unit with refractory insulation added.

Because the C-E High Temperature Water Boiler makes more heat available than does a steam boiler operating at the same pressure . . . because it allows closer temperature control . . . does not require steam traps or elaborate feedwater treatment . . . has no blow down or condensate losses . . . it is finding ever-wider use in large space heating and industrial processing operations.

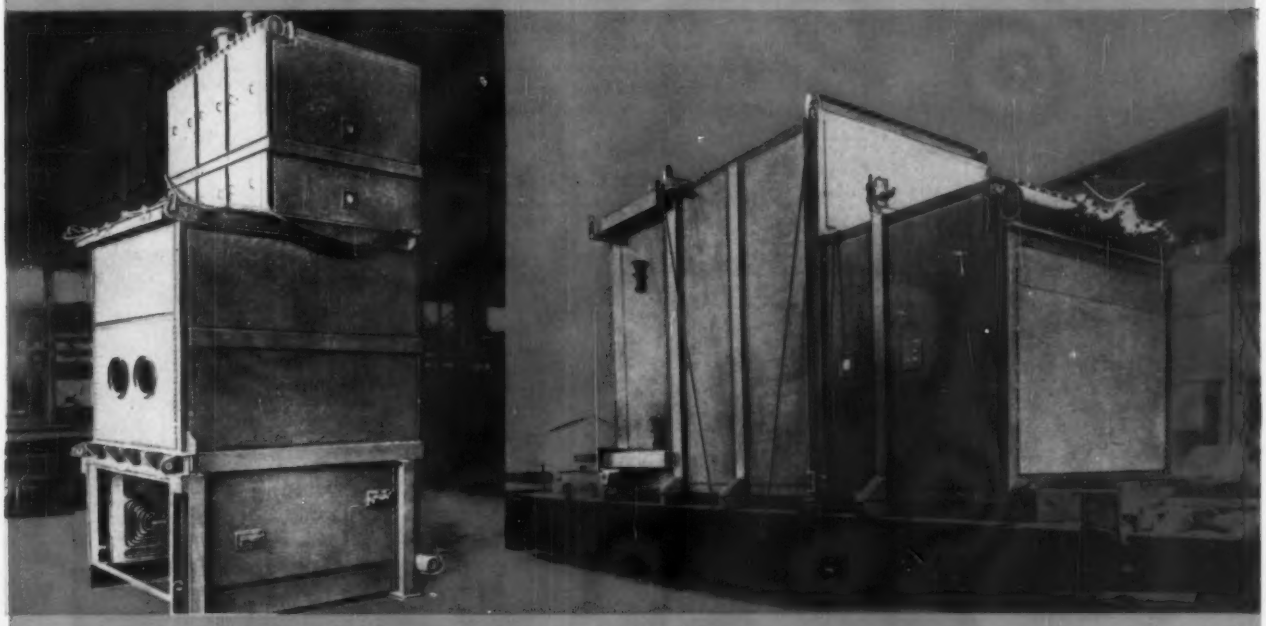
Designed around the same controlled circulation principle used by C-E in many of the world's largest boilers, the C-E High Temperature Water Boiler (Type HCC) operates with low pressure loss. It offers complete control of system and boiler circulation and allows more efficient arrangement of heating surface. It is available for oil, gas, coal or combination firing.

Designed in a wide range of capacities—from 10 million to 300 million Btu's—these boilers operate at water pressures up to 500 psi and temperatures to 470F, or higher. Depending upon local conditions, a C-E Hot Water Boiler can save from 10 to 20 per cent in maintenance and operating costs.

The smaller capacity Hot Water Boilers are completely shop assembled, while the intermediate and large units are shipped in varying stages of assembly.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

WATER BOILERS



3 A 25-million Btu unit completed with welded casing, ready for shipment. Cables are attached to lifting lugs.

4 Compact, completely shop-assembled units from 20 to 35-million Btu are shipped this way.

This C-E practice greatly reduces erection costs.

So, if you are in the market for boilers, either for space heating or process requirements, it may prove to your advantage to investigate the use of high temperature water as your heat source. Because individual needs vary, both steam and hot water have their place. Our engineers will be pleased to discuss either method with you or your consultants — impartially and with no obligation.

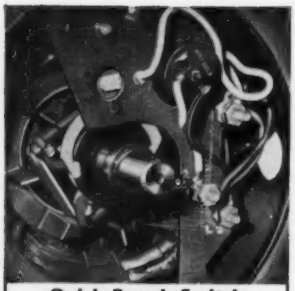
For further details on high temperature water boilers by C-E write for our catalog HCC-2.

COMBUSTION ENGINEERING

C-306

General Offices: Windsor, Conn.
New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater, Ltd.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



Quick Break Switch

The starting winding is disconnected from the line by this Wagner designed switch... test proved to make more than a million breaks. (That adds up to two starts per hour for 50 years!)

Quick Connect Terminals

Brass tabs on terminal studs permit quick, easy connection of leads... cut wiring time to speed assembly line production. Simply press the lead receptacle on to the stud—a positive connection is assured.

NO STARTING PROBLEMS

with

WAGNER CAPACITOR-START MOTORS

Pack more power into less space...give long troublefree service...are easy to hook up

Here are general purpose single-phase motors that have high starting torque and high pull-in torque. When used in the proper application and supplied with voltage close to their rating, they'll give positive starts every time. Troublefree operation is assured... thanks to the positive action of the Wagner governor mechanism and long life quick-break switch.

Wagner Type RK Motors pack more power into less space. Small enough to fit in tight spots, their ruggedness is built-in... permits direct mounting. They are available in a range from ¼ through 5 horsepower, with sleeve or ball bearings, and with rigid bases or resilient mountings. And, sleeve bearing fhp models can be operated in any position.

Get these motors from leading distributors in your city, or from Wagner Sales Offices in 32 cities across the country. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details on Capacitor-Start Motors.

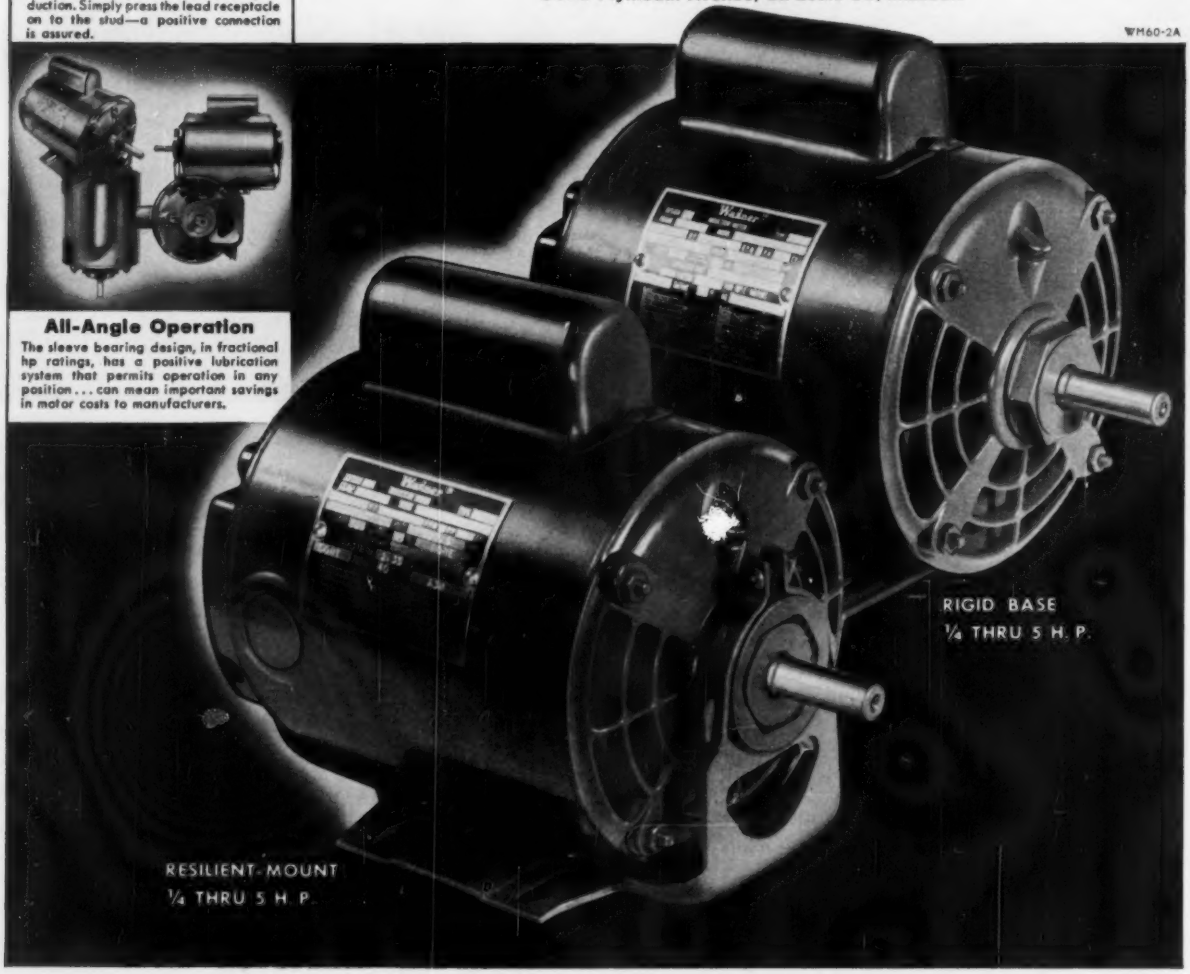
Wagner Electric Corporation

6370 Plymouth Avenue, St. Louis 33, Missouri

WM60-2A

All-Angle Operation

The sleeve bearing design, in fractional hp ratings, has a positive lubrication system that permits operation in any position... can mean important savings in motor costs to manufacturers.



NEW

dpa

HORIZONTAL SPLIT CASE—DOUBLE SUCTION, SINGLE STAGE PACKED PUMP

Capacities to 2800 GPM

Heads to 290 Feet

Discharge Sizes 1½ to 8 inches inclusive

Temperatures to 250° F.

A NEW, QUIET, VIBRATIONLESS PUMP

The new Chicago DPA pump is an exceedingly sturdy, quiet unit providing maximum hydraulic efficiency at all times. Suction, discharge openings and bearing housings are integrally cast into the lower case for maximum rigidity and perfect alignment.

Positive impeller positioning is assured at all times due to a novel and proven design of the rotating assembly. Removal of the entire rotating assembly for inspection is made easy and exact re-alignment assured.

The cast bronze impeller is hydraulically and dynamically balanced and the water passageways hand ground for smooth vibrationless operation. The extra deep stuffing boxes are tapped and bronze lantern rings provided for connection of water sealing.

For further information contact your local Chicago Pump Distributor or write direct for Bulletin 102-A.

fmc CORPORATION ®

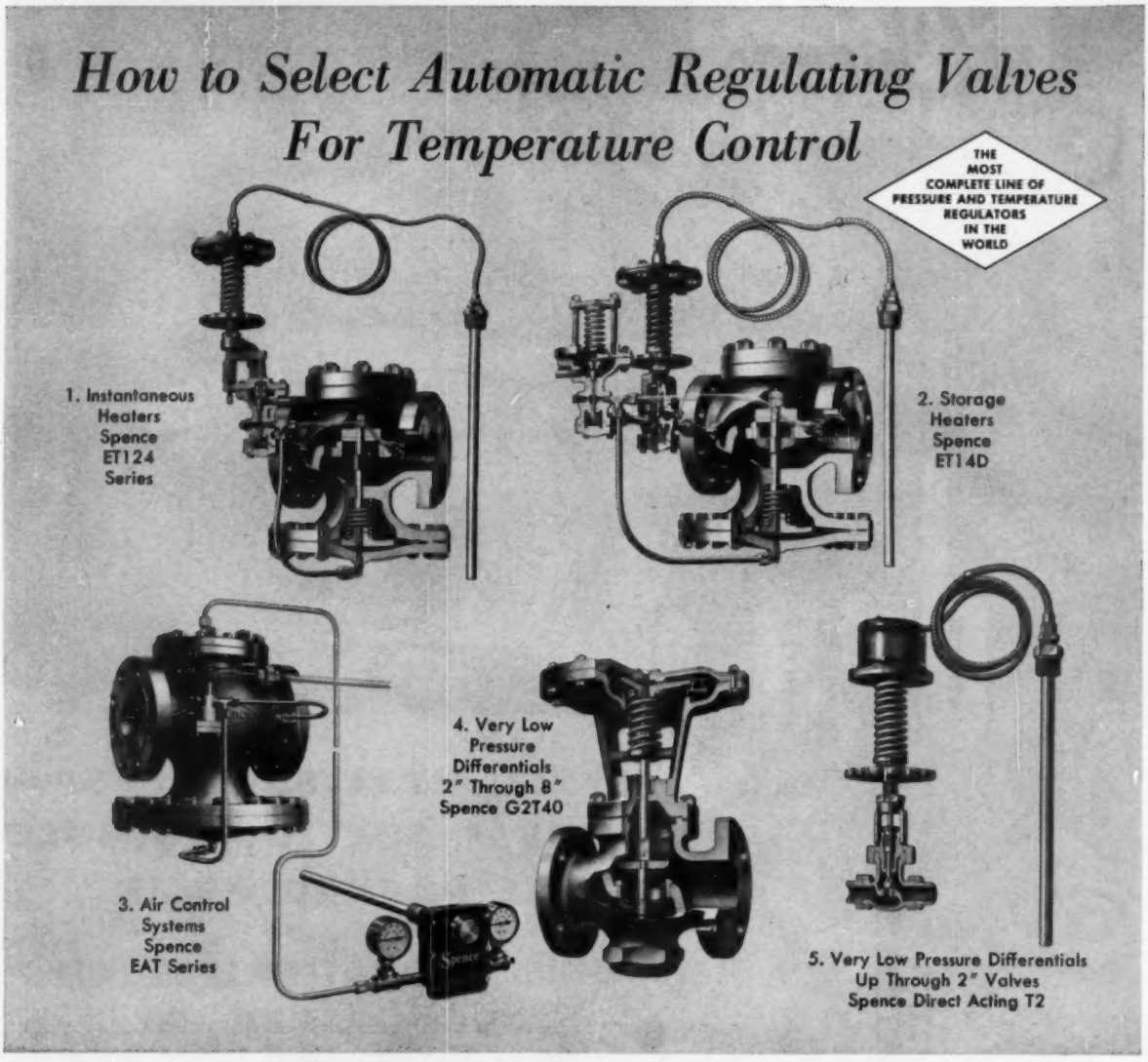
HYDRODYNAMICS DIVISION

CHICAGO PUMP

622C Diversey Parkway • Chicago 14, Illinois

VALVE TIPS:

How to Select Automatic Regulating Valves For Temperature Control


THE MOST COMPLETE LINE OF PRESSURE AND TEMPERATURE REGULATORS IN THE WORLD
1. Instantaneous Heaters Spence ET124 Series
2. Storage Heaters Spence ET14D
3. Air Control Systems Spence EAT Series
4. Very Low Pressure Differentials 2" Through 8" Spence G2T40
5. Very Low Pressure Differentials Up Through 2" Valves Spence Direct Acting T2

During the past year, our field representatives have reported many cases of improperly, and uneconomically, applied temperature regulators. To help you avoid some of these costly mistakes, here are a few tips on selecting the most effective and economical temperature regulating valves for your applications.

1. Instantaneous heaters require a special action for close temperature control and freedom from hunting. In the Spence ET124 series, steam pressure is modulated according to temperature (demand) and is automatically regulated at any pressure established by the demand.
2. Storage heaters, on the other hand, are more economically controlled by the Spence ET14D, which includes a simple temperature-actuated pilot that opens and closes the main valve to maintain a constant temperature.
3. Air control systems can now have a ±5°F control accuracy under wide and instantaneous load swings with the Spence EAT regulator. Engineers report savings of up to 50% in installed costs with this recently developed Spence cascade system when it has been used in place of conventional instrumentation.
4. For the combination of very low pressure differentials and air or water control, Spence recommends Type G2T40. This single seated pilot operated valve provides fast, positive response in 2" through 8" valves. Double seat Type G22 is also available in 10" through 12".
5. When very low pressure differential is encountered with valves of 2" or less, the Spence direct operated T2 is recommended. The sensitive vapor tension thermostat responds quickly to small changes in bulb temperature for continuous, accurate control.

In this brief description of industrial process and heating temperature control, we have given a few important tips in proper regulator selection. If you would like more detailed information on these control applications, write for the new Spence Temperature Control Bulletin IV 1014. 9E-180

SPENCE ENGINEERING COMPANY, INC,
Walden 1, N. Y.

Short cut to improved performance:

Flexpipe® CONNECTORS

Anaconda Flexpipe is a sure shortcut to more dependable heating systems. Its ease of installation and flexibility eliminate a patchwork of elbows, couplings, short runs of pipe. And Flexpipe is easy to work with even in confined areas. Equally important, Flexpipe is designed to take up movement caused by expansion and contraction over a wide variation in temperatures . . . compensate for misalignment . . . and, consequently, deliver far longer service than conventional systems.

Flexpipe core is available in bronze, hot-dipped galvanized steel, or stainless steel. Sizes range from ¼″ through 30″ I.D.

WHERE TO BUY: Leading wholesale distributors can provide information about Flexpipe in standard sizes. For name and address of the distributor serving your area, or for more detailed information, write to: Anaconda Metal Hose Division, Anaconda American Brass Company, P.O. Box 791, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

61-052

ANACONDA®

METAL HOSE DIVISION

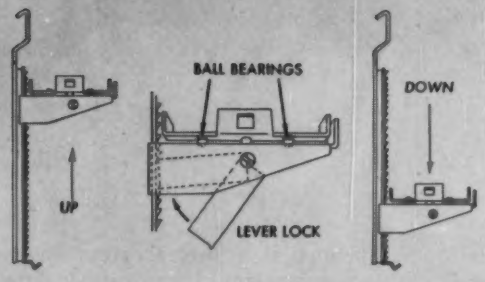
DUNHAM-BUSH FIN-VECTOR

CUTS INSTALLATION COSTS

ONE MAN LINE-UP WITH TWO PIECE BACK

No need for two men to install Fin-Vector. Bottom part of back (use is optional) hangs true from cover retaining strip. Easily handled by one man.

QUICK ELEVATOR ADJUST HANGER BRACKET



Slide up or down for exact pitch required. Snaps and locks tightly in 101 different positions. Exclusive ball bearing feature minimizes noise.

Dunham-Bush Fin-Vector saves installation time, saves money. The secret's "slide 'n snap". Once cover retaining strip is up, you can throw away your tools. All cover and accessory pieces quickly "slide 'n snap" together.

Choice of three new Fin-Vector radiation "wrap-around" covers (front cover—top/front cover—sloping cover) for heating commercial, industrial and institutional buildings. Fin-Vector mounts 1, 2 or 3 tiers high with easy heating element size selection. For wall-to-wall installation, in separate units as convectors or combined with Dunham-Bush Unit Heaters, Heating-Cooling Units and Convectors for a combination of requirements.

DUNHAM-BUSH

Send for complete specification details of Dunham-Bush 'FC', 'TFC' and 'SC' Fin-Vector. Request data sheets No. 1271, No. 1272, No. 1273 and No. 1274.

DUNHAM-BUSH, INC.

WEST HARTFORD 10, CONNECTICUT, U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES

In the new library at John Carroll University...

John Carroll University Library on the campus at North Park and Miramar Drive, University Heights, Cleveland 18, Ohio. General Contractor: The Albert M. Higley Company. Architects: C. B. Rowley & Associates and E. Payer.

Gorman-Lavelle Plumbing and Heating Company installs 55 tons of Republic Steel Pipe

Good for the life of any building, steel pipe waste lines, vents, heating and air conditioning piping were installed in this beautiful Cleveland university library.

Engineers specified steel pipe on the basis of economy and dependability in these applications. *Republic* Pipe was the choice of the Mechanical Contractors, The Gorman-Lavelle Company.

While concentrating on quality of steel and pipe-making techniques, Republic does not overlook the important details. Multiple inspection points *make sure* your pipe has met the requirements of specification standards.

See for yourself. Contact your Republic distributor or write Republic Steel Corporation, Dept. HP-1840, 1441 Republic Building, Cleveland 1, Ohio.

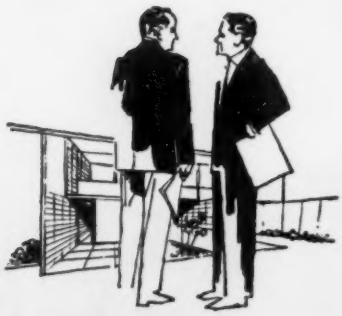
Steel
Strong
Modern
Dependable

CALL FOR REPUBLIC STEEL PIPE

...MADE AND BACKED BY AMERICANS

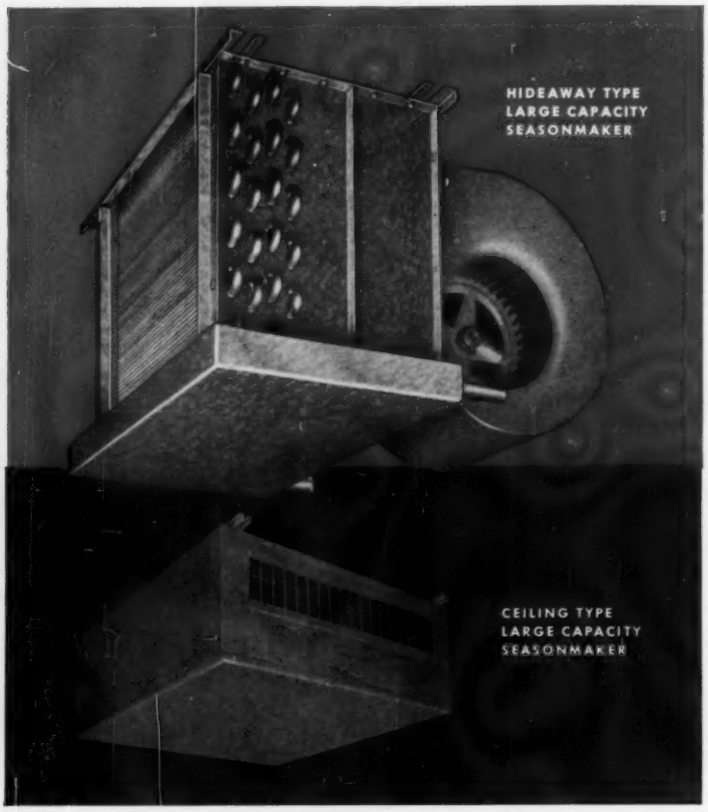
REPUBLIC STEEL

2 to 10 Tons Capacity



USE THESE NEW COMPACT LARGE CAPACITY

McQuay seasonmakers



TO AIR CONDITION ALL MEDIUM SIZED AREAS

When you air condition medium to large sized areas requiring from 2 to 10 tons capacity, compare new McQuay compact large capacity Seasonmakers with all others. Compare the features...compare the quality...compare the quietness ... and you will agree that McQuay leads the field.

- ★ Hideaway models in 4 sizes—800 cfm to 2000 cfm.
- ★ Ceiling models in deluxe cabinets in 4 sizes of direct drive and 5 sizes of belt driven units—800 cfm to 3000 cfm.
- ★ New low height and compact design.
- ★ Permanent split capacitor, resilient mounted motors.
- ★ Choice of five fan speeds.
- ★ Full rated capacity.
- ★ Available with 4 or 6 row cooling coils and 1 or 2 row steam or hot water heating coils.
- ★ Sloped, Styrofoam insulated drain pan.
- ★ Exceptionally quiet operation.
- ★ Rippled fin coil.
- ★ Money saving design for easy installation and minimum maintenance costs.

The McQuay representative in or near your city will gladly give you the complete Seasonmaker story. Call him, or write direct to McQuay Inc., 1601 Broadway N. E., Minneapolis 13, Minn.

Available for immediate shipment

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

QUIET

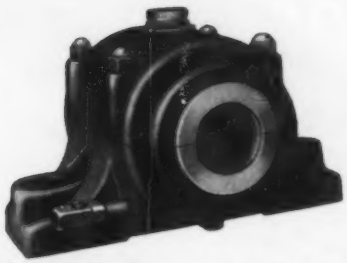
These quality bearings have been developed in close cooperation with manufacturers of fan and blower equipment — to meet the highly specialized requirements of this field.

The nation's great generating plants choose these bearings because of their extraordinary dependability—and the extreme quietness of their operation makes them top choice for air conditioning systems in hospitals, schools, theatres, auditoriums.

Dodge Fan and Blower Bearings are available from stock—with stock-product economy. Consult your local Dodge Distributor—or write us for technical data.

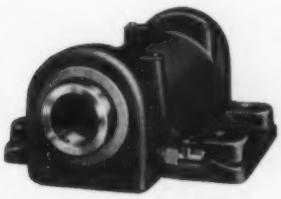
DODGE MANUFACTURING CORPORATION
1600 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.



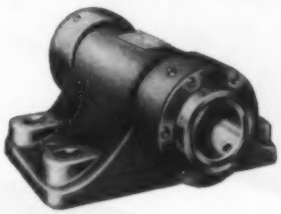
DODGE SLEEVOIL PILLOW BLOCKS

Exceptionally quiet in operation. Noted for superb quality. Plain and Water Cooled Types. Precision-built, ring-oiling, babbitted. Self-aligning. Can be drilled for thermostatic emergency warning. Shaft sizes from 1-7/16″ to 12″.



DODGE BRONZE BUSHED PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two bronze bushings of high lead content mounted in one cast iron housing. Special T-section rings for dependable lubrication. Exceptionally quiet in operation. Shaft sizes from 15/16″ to 2-3/16″.



DODGE BALL BEARING PILLOW BLOCKS

Designed for Arrangement No. 2 installations. Two precision single row, deep groove ball bearings in one cast iron housing. Extended inner race carries shaft. Remarkable ease of installation and maintenance. Shaft sizes from 15/16″ to 2-3/16″.

MANUFACTURER OF AMERICA'S MOST COMPLETE LINE OF MOUNTED BEARINGS

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the white pages of your telephone directory, or in the yellow pages under "Power Transmission Equipment."

Featuring—mechanical shaft seal

Eliminates all leakage from pump shaft . . . keeps floor clean and dry. Pump is self-priming.

dependable performance

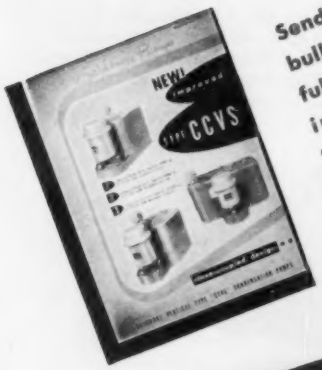
No close clearance . . . efficiency maintained. Especially designed for handling hot condensate.

quiet operation

Features of the CCVS vertical pump design eliminates excessive noise. Can be installed on floor level or in pit.

SKIDMORE CLOSE-COUPLED CCVS PUMP

This new pump combines the latest features in centrifugal pump design with a minimum space requirements. It is built in a capacity range from 500 to 10,000 sq.ft. E.D.R., discharge-pressures from 20 to 40 lbs. The CCVS pump is available in three single unit capacities.



Send for your copy of bulletin No. 21-C which fully describes the new, improved Skidmore "CCVS" condensate pump and complete engineering data.

Here are the answers to— your Heating Pump Problems

Skidmore pumps have set a standard of performance and dependability through continual research and development since 1921.

SKIDMORE PUMPS

SKIDMORE CORPORATION, ST. JOSEPH, MICHIGAN

ANNOUNCING

JOHNSON CONTROL CENTER MODULES

here's
total
flexibility!

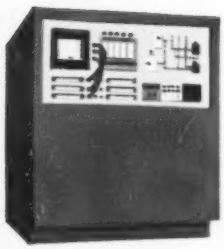
The most advanced development in centralized temperature control, new Johnson modular units permit complete flexibility in control center design and operation. They are adaptable to all transmission systems — pneumatic, electric, electronic.

Besides temperature control, many other functions, such as lighting control, power plant control, communications, and alarm systems, may be integrated into the center. The wide choice of features ranges from conventional data indication and control to automatic digital printing, closed-circuit TV, and screen-projected floor plans and system diagrams. You use as many or as few modules as you wish. Each module is custom-equipped.

Johnson Control Centers are ideal for both new and existing systems in commercial, industrial, and public buildings of any size. For examples of how these compact modular units can be combined to increase system efficiency and make more effective use of manpower, turn the page . . .

Keyed to the Needs of the Individual Building...

Johnson Control Center Modules offer unmatched opportunities for systems efficiency and savings. Check the features of this typical grouping and see why.



MISCELLANEOUS DATA MODULE

Pneumatic indicating receivers, mounted horizontally or vertically, provide continuous indication of key temperatures and pressures. Integral switches indicate off-normal conditions. Optional recording of variables is provided by three-pen, plug-in recorder. Interlocked circuits provide automatic sequence motor control of refrigeration system. Visual indication of operation, manual override, and graphic diagram of the system are also included.

CONTROL CONSOLE

Contains digital clock, digital indication of variables, visual and audible alarms, and intercom system. Master switches determine mode of operation of digital indication and logging. Switches include master on-off, off-normal scan, all-point scan, point hold, scan locked out, printer locked out, off-normal alarm release, audible alarm release, audible alarm locked out, and audible alarm test. Centralized security checks and alarms can easily be included also.

DATA LOGGING MODULE

A high-speed, automatic digital printer provides the building engineer with a permanent record of control data. All off-normal values are printed in red; normal values are printed in black. With parallel print-out, all keys print simultaneously, thus speeding data collection. Logging rate is adjustable up to one point per second. Using Johnson modules, a single center can provide centralized supervision and control for as many as a dozen or more buildings!

Johnson Modular Units Allow You to Centralize All Types of Systems Supervision and Control

AIR CONDITIONING — HEATING

Continuous visual indication of key temperatures, humidities, pressures, liquid levels, etc.

Continuous or optional recording of variables.

Automatic data logging of variables.

Boiler surveillance: steam, oil, and gas pressures; oil level; boiler alarms.

Manual or automatic start-stop controls for fans, pumps, and motors; indicator lights.

Remote sound or TV surveillance of fan room equipment.

Metering of power, water, other services.

Refrigeration machine indication and control.

Summer/winter switchover.

Remote temperature reset.

Indication of filter conditions, valve and damper positions, fuel reserves.

High-low limit alarms.

GRAPHIC DIAGRAMS

Color coded representation of system and equipment on panels or screen-projected slides.

FIRE AND RAID ALARMS

Fire detection system with central alarm and location indication.

Conelrad air raid warning tied into central alarm and communication systems.

CLOCK SYSTEMS

Centralized programming of master and individual clocks and time signals.

SECURITY SURVEILLANCE

Closed circuit TV from remote areas.

Audible alarms; sound detection.

LIGHTING SYSTEMS

Manual or automatic programming.

Light level controls.

COMMUNICATIONS

Master intercom and music systems.

Paging center.

Closed circuit TV and radio intercom for remote supervision of repairs and installations.

MISCELLANEOUS SYSTEMS

Snow melting, lawn and sprinkler systems, control.

Time recording systems, machine operations.

Indication of gas, radiation, or other hazardous conditions.

Transformer indication and control.

Indication and control of boiler and turbine operations.

Feed water conductivity, analysis, and flow.

Domestic hot water control.

JOHNSON CONTROL

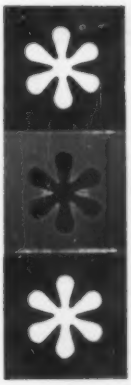
PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

For details about Johnson Control Centers, write for Bulletin 1040.
Johnson Service Company, Milwaukee 1, Wisconsin.

Printed in U.S.A.

you'll want to know...



C.E.C. Adopts Technical Literature Indexing System

A STANDARDIZED indexing system for categorizing the reams of technical brochures and catalogs distributed by equipment manufacturers was accepted by the Consulting Engineers Council at its semi-annual meeting held last month in Miami Beach, Fla. The new system, which is divided into four major sections, was developed under the direction of a special task force committee chairmaned by Robert W. LaTour, of Bosch and La Tour, consulting engineers, Cincinnati, Ohio.

It is the hope of the consultants that their system will, after an appropriate trial period, be accepted by U.S. manufacturers to the extent that the C.E.C. file numbers will be published on technical literature in much the same way AIA file numbers are now published on such material.

The principal speaker at the meeting, U.S. Chamber of Commerce President Richard Wagner, urged consultants "to assume the front ranks of all community betterment programs," and to "oppose intervention of federal authority which seeks to dictate methods of solving local improvement problems." Mr. Wagner said that "consulting engineers particularly suffer from federal competition."

Another action taken at the meeting was the establishment of an Ohio Association of Consulting Engineers and the approval of a membership application submitted by the Arkansas Association of Consulting Engineers. These groups bring to 34, the number of state or regional consulting associations affiliated with the C.E.C.

The meeting also saw . . . approval of new C.E.C. mechanical-electrical special conditions of the contract . . . clearance to proceed with a professional insurance program for consulting engineers . . . reiteration of the Council's opposition to competitive bidding . . . and an invitation to President Kennedy to make wide use of consulting engineers in the Government's fallout shelter survey program.

Construction To Score 17th Consecutive Record Year in 1962

CONSTRUCTION will enjoy its best year in history and set a new record for the 17th consecutive year, according to the latest F. W. Dodge Corp. construction outlook. The report states that total construction contracts in 1962 will amount to nearly $40 billion, a gain of 7 percent over the estimated $37.3 billion for this year.

Of this total, non-residential contracts will register a 4 percent gain, and will amount to $12.7 billion. Floor area represented by these contracts is expected to rise 3 percent, primarily because of a 10 percent jump in manufacturing buildings. Floor area of commercial buildings is expected to equal the 1961 total, while the physical volume of educational and science buildings is forecast to increase 2 percent. With the exception of hospitals, which are predicted to slip just below the 1961 level, all other building types in the non-residential category will register small gains in 1962.

Establish Industry Certification Program For Fan-Coil Air Conditioners

AN INDUSTRY certification program for room fan-coil air conditioners is scheduled to become operative in October, 1962. The sponsors of the program are the Air-Conditioning and Refrigeration Institute, the Air Moving and Conditioning Association, Inc., and the Institute of Boiler and Radiator Manufacturers.

Designated "Industry Standard 441," the program has been accepted by the industry through the efforts of the Fan-Coil Coordinating Committee, representing manufacturers of this type of equipment from the memberships of the three sponsoring organizations.

While the program will be administered by ARI, the Fan-Coil Coordinating Committee will continue as an advisory group to consider matters of general policy within the program. Actual drafting of the standard was accomplished under direction of the Joint Engineering Committee on Fan-Coil Units, set up by the coordinating committee, and this joint committee will continue to function as a technical advisory committee.

The Fan-Coil Rating Committee, also established under the coordinating committee, is responsible for carrying out the intent of the program, including the procedures of examining certification data and approving ratings on the basis of check-testing of sample units; interpreting policy as set forth in the standard, and in the license agreement which each participating manufacturer will sign; and otherwise assisting in operation of the program. The Fan-Coil Rating Committee is made up of the chief technical staff officers of the three associations, under chairmanship of the chief engineer of ARI.

Manufacturers representing more than 80 percent of the production volume of fan-coil units have signed agreements to participate in the program.

Participants in the program need not be members of any of the three sponsoring organizations to obtain approved standard ratings for their products. The program requires that a license agreement be executed between the manufacturer and ARI, which specifies the conditions of participation and authorizes publication of approved standard ratings and display of the certification symbol by the licensee when the conditions of participation have been satisfied. Both cooling and heating capacity ratings are to be expressed in Btu per hour.

Certified ratings will be published in a "Directory of Certified Room Fan-Coil Air-Conditioners," similar to the ARI "Directory of Certified Unitary Air-Conditioners," and will be issued periodically so that ratings are kept up-to-date.

Participation in this program requires, in addition to the manufacturer's own testing of his product prior to certification, precertification check-testing at an independent laboratory of equipment proposed for certification. During the period between now and October 1962, participating manufacturers will be accomplishing this precertification testing.

No manufacturer or any other corporation, firm, or individual may publish approved standard ratings, or display the certification symbol on his products or in his literature, unless and until he has received written authorization from ARI.

A room fan-coil air-conditioner (also referred to in the standard as a "fan-coil unit") is defined as ". . . a factory-made assembly which provides the functions of circulation, cooling or cooling and heating, and filtering, of air, but which does not contain the source of cooling or heating. This device is normally designed for free delivery of air into a room, but may be applied with minimal duct work having static resistance not exceeding ¼ in. WG. This device may be designed for furred-in application, or with an enclosure for application within the conditioned space. This device is generally designed in sizes of less than 1500 cfm air delivery."

Edmund P. Heckel — Air Conditioning Pioneer

THE air conditioning industry lost one of its founders recently with the death of Edmund P. Heckel. He was 79 years old.

Mr. Heckel began his career with the Buffalo Forge Co. in 1905. In 1915 he was one of the founders of the Carrier Engineering Corp., now the Carrier Air Conditioning Co.

Mr. Heckel left Carrier in 1939 to found the firm of E. P. Heckel & Associates, consulting mechanical engineers. He retired and dissolved the firm in 1960. The American Society of Heating and Air-Conditioning Engineers elected him to the grade of Fellow in 1957 for his contributions to the industry.

A long time contributor to HPAC, and a member of HPAC's Board of Consulting and Contributing Editors, Mr. Heckel's articles for this magazine date back to 1936. Among them were articles on design of facilities for environmental control research at the University of Illinois, and industrial air conditioning.

Largest Steam Utility Uses Prefabricated, Preinsulated Distribution Mains

NEW YORK'S crowded Manhattan Borough uses a prodigious amount of steam to keep warm in winter, cool in summer, and for various manufacturing and other processes. And with Manhattan growing up in the air at a staggering rate, New York's Consolidated Edison Co., the largest steam utility in the country, is required to furnish ever increasing amounts of steam all the time. Hourly peak loads have already reached 9 million lb.

Repairing steam distribution lines in this area is always a problem; streets and street congestion dictate that repairs and alterations be accomplished in the shortest time possible. The utility has solved some aspects of this problem by using prefabricated and preinsulated steel-jacketed steam mains.

WORKMEN lay a 24 in. diameter prefabricated and preinsulated steam main in Manhattan. The 40 ft main has an overall 36 in. OD and weighs 12,565 lb

Both mains and service pipes are in 40 ft lengths, preassembled by the H. C. Price Co., Philadelphia, Pa. Thirty-nine ft of the mains (or pipe) are covered with insulation and enclosed in an outer steel conduit. Six in. at each end are left uncovered to permit welding together. Mains of 6, 8, 10, 12, 16, 20, and 24 in. diameters are used. Service pipes range down to 1 in. in diameter. Twelve to 24 in. mains have 4 in. of molded insulation. Those from 10 in. down to a 6 in. diameter have 3 in. of the same insulation.

In the prefabrication process, the carbon steel mains are held by a mandrel at one end. Cylindrical insulation is slipped over the mains from the free end in 3 ft sections. The texture of the sectional ends of the insulation is such that they mesh together. The joints are then sealed with asbestos tape. Cast iron pipe supports and rollers are located on 21 in. centers from each end, and for these the necessary insulation was cut away.

The protective conduit applied over the insulated mains is spiral wound steel piping welded at the seams. The outside diameter is such that almost 2 in. is left between the inside wall and the surface of the insulation on all sides. For example, 36 in. conduit is used for a 24 in. main. Steel angles are welded between the mains and conduit at each end to keep conduit in place over the mains and to keep insulation from slipping out of place during shipment. They are cut off at the job site. The outside surface of conduit is protected by a hot line enamel.

Installed sections have bellows expansion joints every 200 ft. Thrust anchor plates are applied between expansion joints and bends in mains, 100 ft from the expansion joints, eliminating any expansion against the bend itself. Intermediate anchors are located between joints on 100 ft centers.

After the sections of main are joined by welding, the exposed surface on either side of the joint is covered with insulation. The area is then covered by half-cylindrical sections of steel conduit, which are welded together and to the adjoining prefabricated sections. Outside surfaces are then protected with a tar base epoxy resin, applied cold.

When earth fill is backhoed over the mains, the conduit is flattened into a somewhat eliptical shape. The compressive lateral thrust of the conduit sides in assuming the elipse locks the conduit against the surrounding earth. The degree of bending is not enough to either impair efficiency of insulation or to damage it in any way.

Establish Air Pollution Sampling Network

A SPECIAL air pollution sampling network has been established covering Washington, D.C., and the nearby areas of Maryland and Virginia. The network began operation September 26 under the

you'll want to know

joint sponsorship of the U.S. Public Health Service and the Washington Metropolitan Regional Conference.

The sampling stations are measuring total oxidant, a type of air pollution associated with smog formation. Oxidant is produced in the atmosphere by the photochemical action of sunlight on emissions from automobile exhaust and other sources.

ASHRAE Research Lab Given to Kansas State

THE ENVIRONMENTAL Research Laboratory of the American Society of Heating, Refrigerating and Air-Conditioning Engineers is currently being transferred to Kansas State University, Manhattan, Kan., for K-State's Institute for Environmental Research.

The Laboratory and its associated equipment represents a total investment of approximately $150,000. It will be housed in a $160,000 building for which the University received an $80,000 National Institutes of Health grant in late September.

Under the agreement between ASHRAE and the University, K-State will carry on several of the Society's current research projects, with the Society financing this research on a cooperative basis. A number of other outside sources will be contributing substantial support to the research programs planned for the Institute, according to K-State president James A. McCain.

Dr. Ralph Nevins, head of the mechanical engineering department in K-State's School of Engineering and Architecture will direct the new Institute. Dr. Nevins is currently chairman of the ASHRAE research panel on physiological research, and human comfort.

The laboratory itself is a test room 12 by 24 ft in size. With its associated equipment including heaters, air conditioning units, fans, etc., it is possible to control temperatures on all six wall surfaces, as well as to control the temperature, humidity, air movement, and air cleanness.

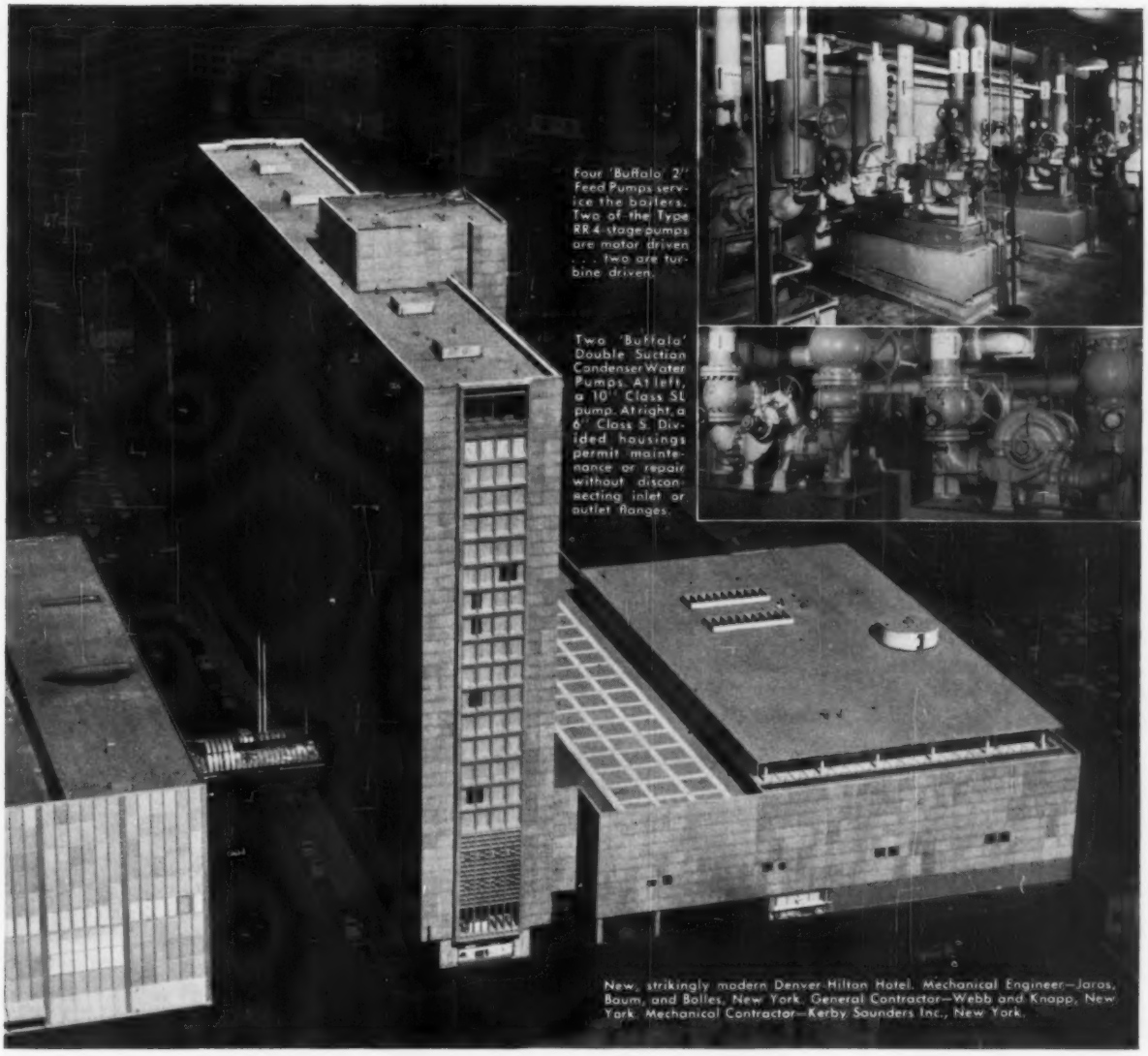
Dry Fluid Drives Eliminate High-Inertia Starting Problems

THE WOOLWORTH BUILDING'S 1500 ton air conditioning system now delivers cool comfort to its inhabitants. Three cooling towers, each with a 50 hp fan motor, deliver a total of approximately 450,000 cfm for the Manhattan, N.Y., skyscraper.

When the cooling system was first installed, the fan drives consisted of a 10.6 in. pitch diameter motor sheave and a 56 in. driven shaft sheave to achieve 220 rpm fan speeds. Full load rated current on the motors was 133 amp, and each drive was pulling an average of only 100 amp when running. However, there was considerable difficulty in starting the fans because overload relays would drop out during the long starting period. Starting current on the motors was in excess of 400 amp, which was often held for as long as 30 sec—the time required for the fans to come up to speed.

The solution was to install a dry fluid drive to each of the motors, according to Dodge Mfg. Corp. This brought full operating current to 126 amp on each motor, and starting current to under 250 amp at its highest point. An 11.5 in. pitch diameter motor sheave was installed on each motor, replacing the 10.6 in. sheaves, and increasing the efficiency of the blowers. And in addition, a squealing noise and stretching of belts was also eliminated.

The mechanical contractor for the installation was Hydrocol, Inc.



Four 'Buffalo' 2" Feed Pumps service the boilers. Two of the Type RR 4-stage pumps are motor driven . . . two are turbine driven.

Two 'Buffalo' Double Suction Condenser Water Pumps. At left, a 10" Class SL pump. At right, a 6" Class S. Divided housings permit maintenance or repair without disconnecting inlet or outlet flanges.

New, strikingly modern Denver-Hilton Hotel. Mechanical Engineer—Jaros, Baum, and Bolles, New York. General Contractor—Webb and Knapp, New York. Mechanical Contractor—Kerby Saunders Inc., New York.

No "reservations" necessary

FOR 'BUFFALO' PUMPS AT THE DENVER-HILTON

Engineers and contractors certainly had no reservations about the use of 'Buffalo' pumps in the beautiful Denver-Hilton. 'Buffalo' pumps were chosen for practically every type of liquid handling service in this ultra-modern hotel . . . from boiler feed pumps to cooling tower pumps . . . from air conditioning pumps to circulating pumps for sidewalk snow removal.

All told, 'Buffalo' centrifugals ranging from 2" to 10" in size, 50 to 2500 gpm capacities, and 55 to 560 ft. heads were specified.

'Buffalo' installations similar to this (the choice of pump models will vary) can be found in growing numbers throughout industry and commerce. 'Buffalo' quality and the ability to perform quietly, efficiently, dependably, and at lowest cost are "reasons why."

Resident Buffalo representatives, located in over 75 major industrial areas in the U.S. and Canada, will be glad to discuss requirements for your next installation. Chances are excellent there is one near you. If not, write Buffalo Pumps direct.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canada Pumps Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

FOR AIR CONDITIONING . . .

Get exact water control through

Exclusive Honeywell design makes the difference in pneumatic valves!

CHECK THESE HONEYWELL DIFFERENCES:

THE ACTUATOR

1 **Rolling-type diaphragm** assures constant effective area throughout stroke, provides maximum power when needed.

2 **Snap-seal** bead on diaphragm. The higher the pressure, the tighter the seal.

3 **Bullseye stem button design** maintains smooth stem travel, eliminates side thrust, assures positive positioning.

THE VALVE

4 **Specifically designed** to modulate hot and cold water in sequence.

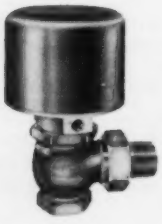
5 **Two contoured plugs** insure equal percentage output for either hot or cold flow.

6 **Body is a brass forging** and all internal parts are brass or stainless steel with rubber seals.

7 **Spring-loaded, self-adjusting** rubber packing rings eliminate field packing adjustments.

The Honeywell VP522A is the only modulating sequencing valve specifically designed to control the flow of both hot and cold water to fan-coil and induction units. This three-way, pneumatically-operated valve assures maximum power when you need it most—when the valve is approaching the closed position. The flexible, rolling-type diaphragm keeps the effective area of the actuator constant, regardless of the position of the diaphragm itself. Bullseye action by the stem retainer and contoured plug prevents side thrust, provides more sensitive, precise flow control.

The assembly is corrosion resistant. Molded-in composition discs assure tight shut-off. Two inlets and a common outlet are threaded for ½ inch, ⅜ inch and ⅞ inch OD flare fittings to cover the additional requirements of this valve. Only Honeywell offers this selection. And the actuator can be rotated 360° on the bonnet, permitting easy alignment with air piping from any direction. For full details, call your nearest Honeywell office. Or, write Honeywell, Dept. AC-4-79, Minneapolis 8, Minnesota. In Canada write Honeywell Controls, Limited, Toronto 17, Ontario.

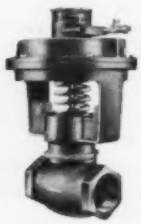


Pneumatic Radiator Valves VP520A, VP520C

Direct-acting, normally open, single-seated valves in straight-through, straight-through offset or angle patterns. VP520A is modulating for two-pipe steam and hot water systems. VP520C is used with a 2-position controller on one-pipe steam systems.

Three-way Pneumatic Coil Valve V5013A

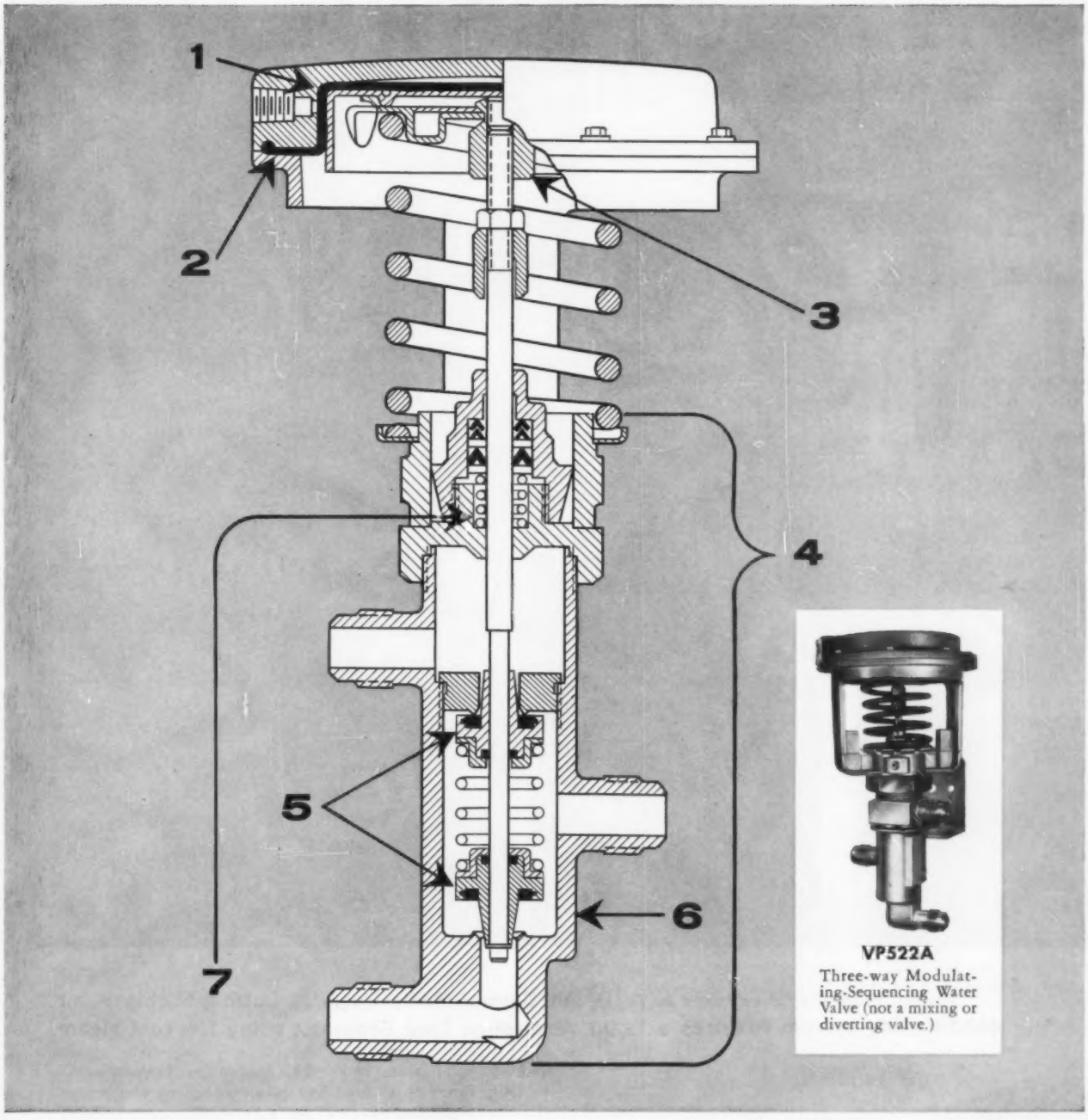
Can be used for mixing service to direct two inlets to a common outlet. Should not be used to divert flow from a common inlet to two outlets. For use with pneumatic, electric or electronic operators to form a motorized valve assembly for the control of hot or chilled water.



Single-Seated Valve Bodies V5011A, V5011B

Straight-through, globe-type valves with cast-bronze screwed ends or cast-iron flanged ends. V5011A is direct-acting. V5011B is reverse-acting. Excellent flow control is achieved by using equal-percentage, high-lift, plug-type throttling guides.

"Constant Power" actuation



VP522A
Three-way Modulating-Sequencing Water Valve (not a mixing or diverting valve.)

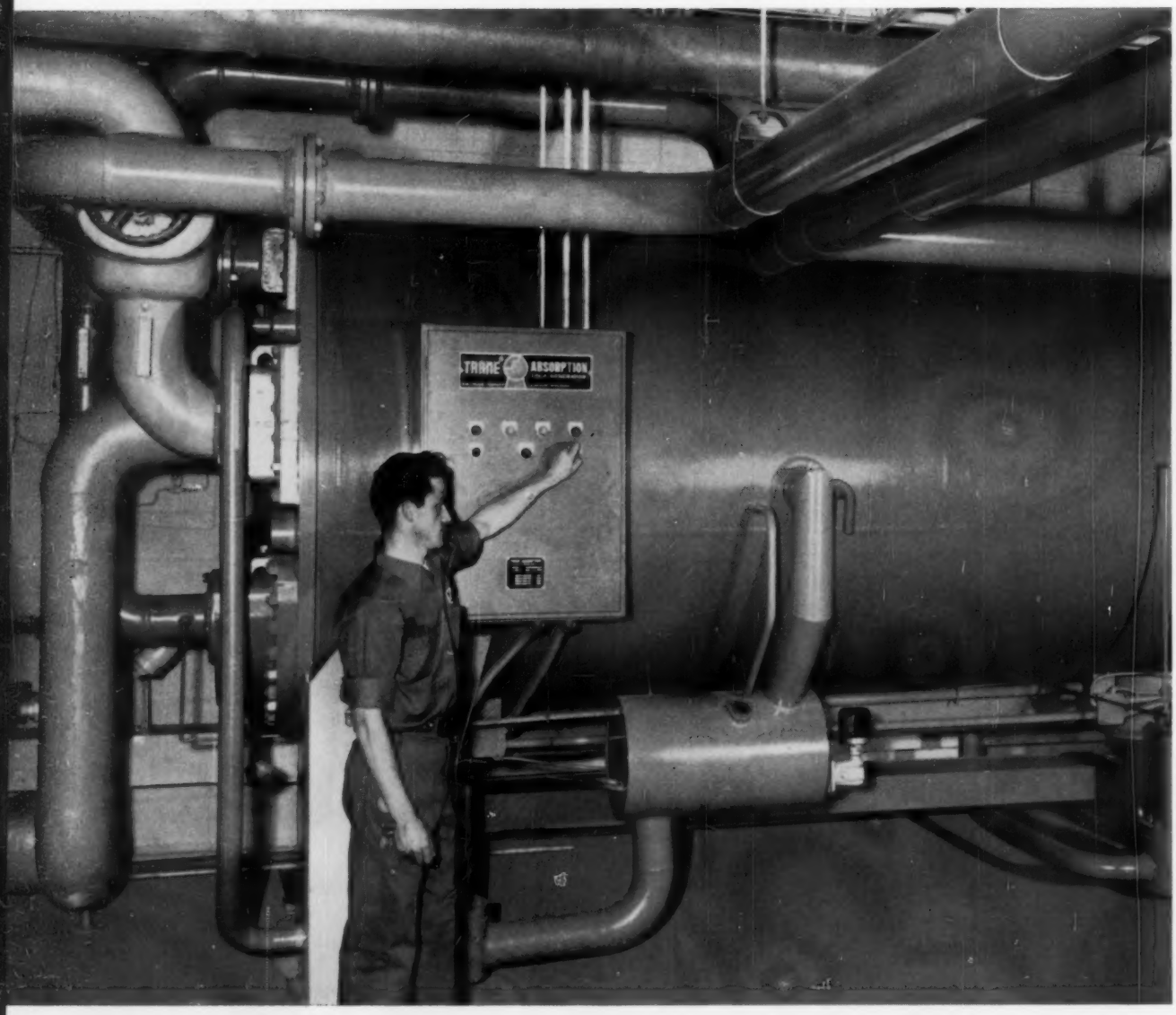
Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Exclusive hermetic design of assures dependable, economical



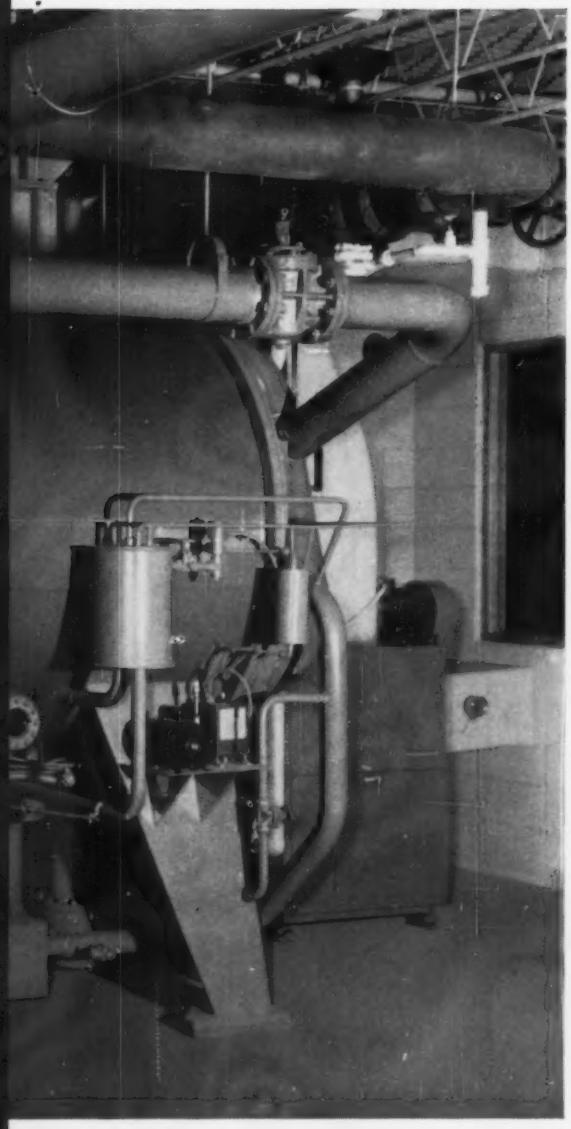
Another hospital air conditioned by TRANE: **Mt. Carmel Mercy Hospital, Detroit, Michigan, air conditioning system features a TRANE Absorption Cold Generator using low cost steam**

This 554-bed hospital received its first patient 23 years ago—in 1938. Since that time, five major additions and a continuous remodeling program have kept Mt. Carmel Mercy Hospital one of the most modern and efficient large hospitals in the United States.

The TRANE Absorption Cold Generator is located in the penthouse of the latest addition. It draws steam from an adjacent power house, and it chills water used to air condition the cafeteria, kitchen, dining room, executive offices and the children's playroom.

Because the unit does not require a full-time attendant, hospital administrators found they could free an operator for other maintenance work.

Trane Absorption Water Chiller operation and longer life



Long equipment life, superior reliability with low operating costs, minimum maintenance! The reasons more and more engineers specify TRANE Absorption Cold Generators.

Superior reliability, longer life

The exclusive hermetic design of TRANE Absorption Cold Generators assures much longer life than you can expect with water chillers having solution pumps with shaft seals. Air is prevented from entering the system where it could cause loss of capacity, increase in steam consumption, crystallization and deterioration.

All TRANE units are assembled at the factory. All refrigerant and solution piping is welded at the factory. No field welding is necessary—so every TRANE Absorption Cold Generator can be tested for air leaks before shipment with superior laboratory-type equipment. TRANE tests each unit with a helium mass spectrometer that is 10,000 times as sensitive as the best electronic leak detection equipment.

The TRANE Absorption Cold Generator—unlike other absorption machines—tends to free itself if crystallization is caused by temporarily abnormal conditions, such as power failure. Here's an actual case of how quickly and effectively this exclusive TRANE feature works: When a hurricane struck Charleston, South Carolina, there was a power failure. Within 30 minutes after power was restored a TRANE Absorption Cold Generator located in one of Charleston's largest motels, returned to normal operation. Other machines require a stand-by power source to eliminate costly crystallization damage.

Low operating and maintenance costs

TRANE Absorption Cold Generators operate efficiently down to 10% of capacity. And because these units are fully automatic in operation, a full-time attendant is not required.

TRANE Absorption Cold Generators have hermetic pumps that are automatically cooled and lubricated. The frequent and costly maintenance required by open-type pumps and complicated purge systems is avoided. There is no need for frequent seal replacements which involve draining the solution from the unit, re-evacuation, and recharging before operation can be resumed.

Wide selection is another reason why engineers specify TRANE. The TRANE Absorption Cold Generator is available in capacities ranging from 100 to 530 tons. There are twelve basic sizes for wide selection flexibility in the 100 to 530 ton range.

These are the reasons why throughout the country more and more engineers are specifying TRANE *Absorption equipment for low cost cooling of offices, hotels, motels, hospitals and factories.*

WANT MORE FACTS? . . .

Check your nearby TRANE Sales Office for more information on the TRANE Absorption Cold Generator — and for a list of installations in your area. Or write direct to TRANE, La Crosse, Wisconsin.

For any air condition, turn to

TRANE

Manufacturing engineers of air conditioning, heating, ventilating and heat transfer equipment

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 101 U.S. AND 20 CANADIAN OFFICES

In Milan, Italy

PIRELLI SKYSCRAPER, Milan, Italy. Architect: Gio Ponti; Contractors: Aerotecnica Marelli Company and Aster Company.

GENERAL MILLS BUILDING, Golden Valley, Minnesota. Architects & Engineers: Skidmore, Owings & Merrill; Mechanical Contractor: Reuben L. Anderson—Cherne, Inc.; Ventilation Contractor: Iowa Sheet Metal Contractors.

. . . in Minnesota . . . . in California . . .

KAISER CENTER, Oakland, California. Architects: Welton Becket & Associates; Mechanical and Electrical Engineers: Dudley Deane & Associates.

three building-planning groups came to the same decision:

CLEAN AIR by AAF

Facts behind the decision:

Fact No. 1—Unless you consider *all kinds* of air filters, you can't be sure of getting *optimum* correlation of filter performance, filter cost and filter maintenance.

Fact No. 2—AAF is the one-and-only company that *makes* all kinds of filters.

From the score of filters in the AAF line, there's one that's engineered and constructed to give you the *air-cleaning efficiency you need plus the maintenance characteristics you want.*

Take a look at what we mean by a *complete* line of air filters. Call your local AAF representative or write direct for Bulletin 510B. Address: Mr. Robert Moore, American Air Filter Company, Inc., 373 Central Avenue, Louisville, Kentucky.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

How to obtain comfort at a comfortable cost

in commercial, industrial and institutional buildings

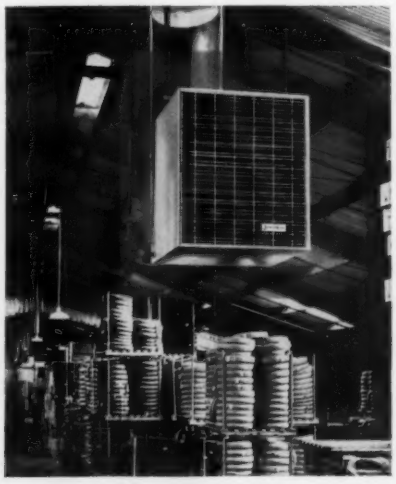
Mayfair Shopping Center, STOCKTON, CALIFORNIA

Designer-Engineer: Klar Wennerholm, Stockton. General Contractor: Nomellini Construction Company, Stockton. Heating and Air Conditioning Contractor: Pacific Plumbing and Heating Company, Stockton. Developer: Art Basso.

Suspended Janitrol 67-Series gas unit heaters and blower coil cooling packages are used throughout the 17-store Mayfair Center. The advantages are many. No ductwork required. Big savings in labor and material costs. Valuable floor space saved for *selling*. The compact, smartly-styled Janitrol units blend harmoniously with the interiors. Janitrol 52-Series air-cooled condensing units are remotely located on the roof.

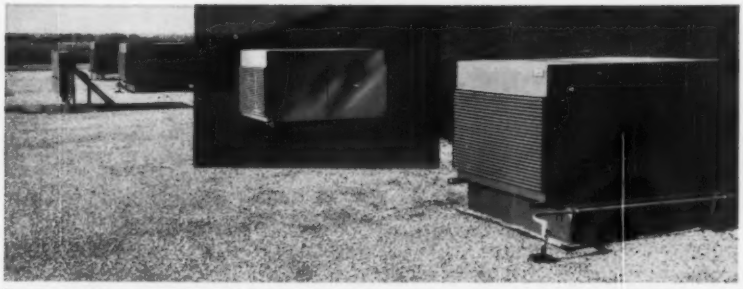
White Stores, Inc., WICHITA FALLS, TEXAS

. . . has 19 Janitrol 67-Series unit heaters in this new 106,000 sq. ft. warehouse, located in Farmers Branch (Dallas) Texas. The heaters are suspended over the aisles at 100 foot intervals, and each unit has 250,000 Btu./hr. capacity. White's have used Janitrol for many years in their retail stores, based on Janitrol's attractive appearance and record for performance and economy.



Hanscom Candy & Pastry Shop
Wynnewood Shopping Center
WYNNEWOOD, PA.

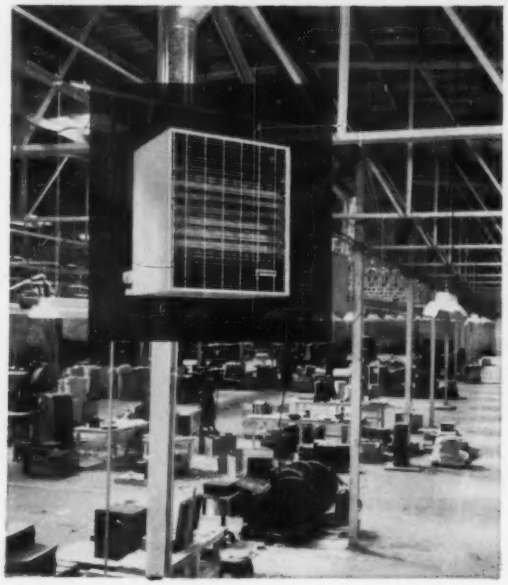
The false acoustical ceiling serves as a plenum, and special, slotted supporting channels serve as strip diffusers in this unusual Janitrol application. The conditioned air, under slight pressure is distributed quietly and evenly. This low-cost system required only one supply and one return duct connection, in combination with a Janitrol duct furnace, blower coil and condensing unit.



Meridian Lanes Bowling Center
OKLAHOMA CITY

Architects and Engineers: Bramble and Baldwin, Oklahoma City. General Contractor: Everett Construction, Oklahoma City. Heating and Air Conditioning Contractor: Barlow and Matherly, Oklahoma City.

Seven-zone comfort control was economically achieved at the Meridian Lanes Bowling Center with seven, individual Janitrol year 'round systems. The Janitrol 52-Series air-cooled condensing units are mounted on the roof. They operate without water, need no sewerage service, and provide cooling with outside temperatures up to 125°F. All other equipment for this heating-cooling system (except two small furnaces) is installed either on the roof or in the attic space. 100% fresh air in any of the public areas is assured by this system—plus stand-by capacity, in the event any single unit is being serviced.



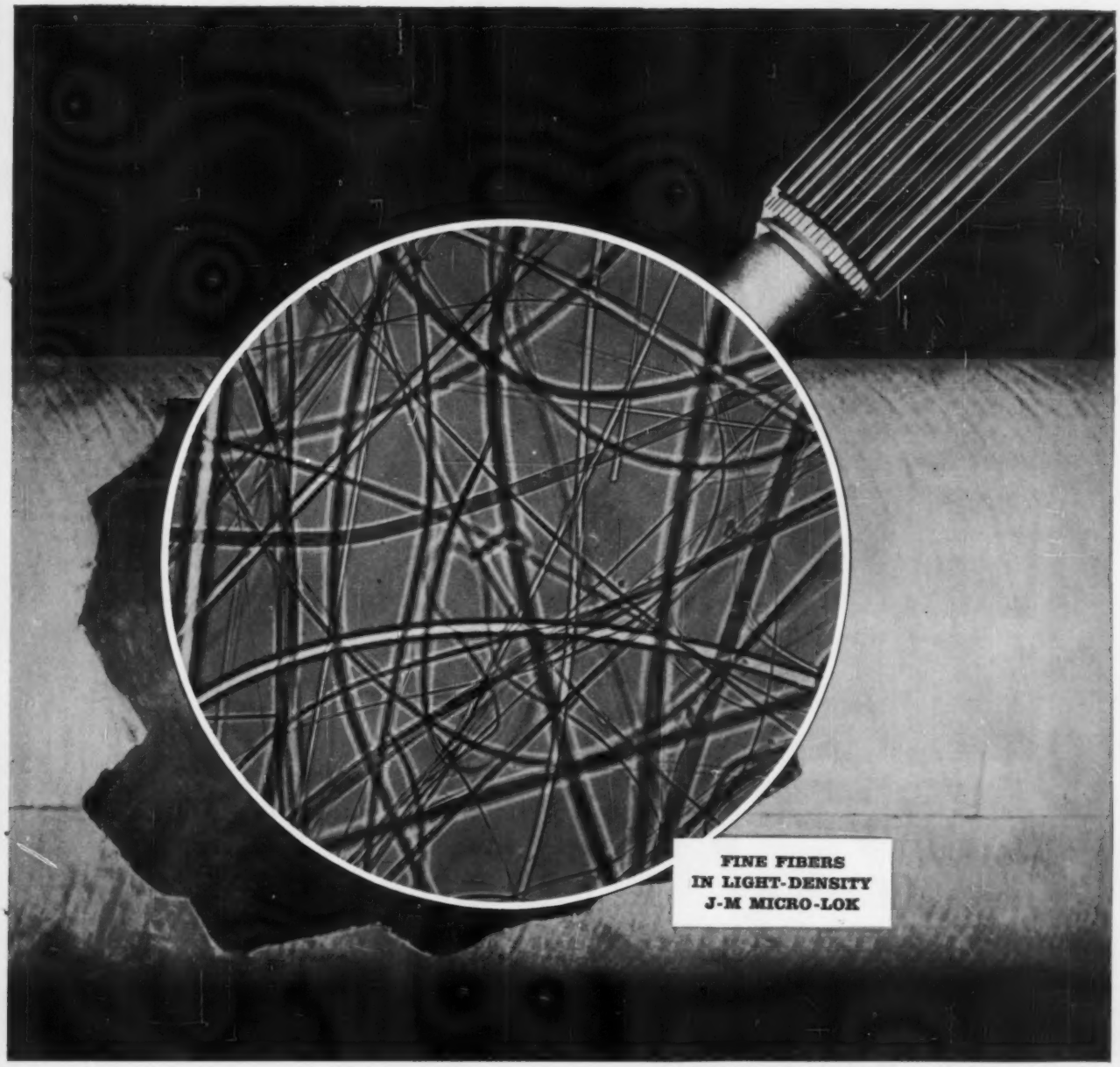
Detroit Gasket & Manufacturing Company NEWPORT, TENN.

This modern manufacturing facility was converted from a tobacco warehouse. The original building was unheated, so eight Janitrol 67-Series gas unit heaters were installed in the plant area, and a Janitrol year 'round system conditions the office. Mr. T. H. Ellis, Manager, reports that the Janitrol units were easy to put in, give excellent wide-area comfort and seldom need maintenance attention. Heating and Air Conditioning contractor: Brannon Electric Company, Newport, Tennessee.

For more information on Janitrol products, see our catalog in Sweet's File 31b/Ja, contact your local Janitrol office or write headquarters in Columbus.

A DIVISION OF
JANITROL® M-R
HEATING AND AIR CONDITIONING
COLUMBUS 16, OHIO
IN CANADA: MOFFATS LTD., TORONTO 15

See why lighter density makes **J-M MICRO-LOK** most effective... most economical



Photomicrographs of glass fibers at 250x magnification

Micro-Lok pipe insulation is made of long, resilient, extremely fine glass fibers. This means that infinitely more and smaller air pockets are created than would be formed by coarse, more rigid fibers made by an old-fashioned process.

Thus, Johns-Manville Micro-Lok provides considerably more resistance to the passage of heat, yet its density is only about half that of pipe insulations made of coarse fibers.

Specifically, fine-fibered, light-density Micro-Lok has a k factor of .245 at 100F mean temperature – about 10% *lower* than coarse-fibered, heavy-density products.

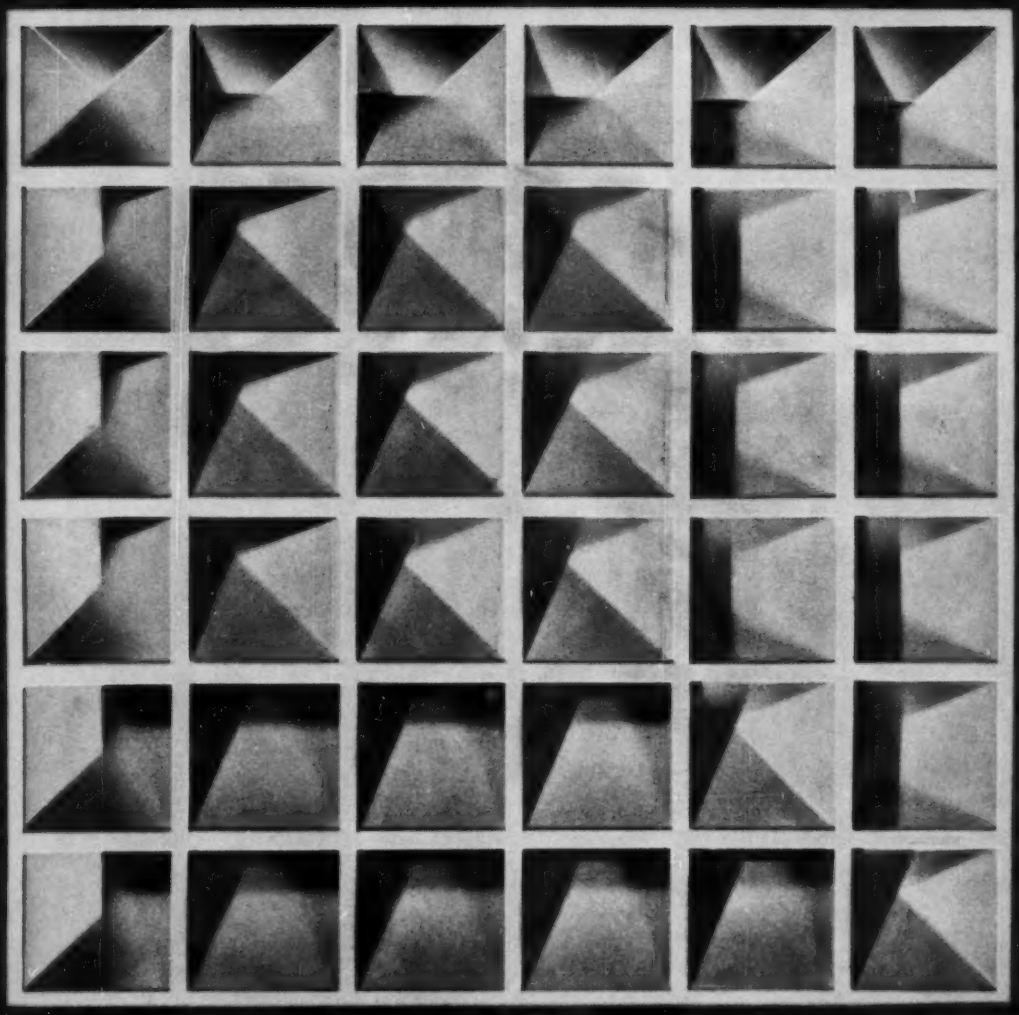
Micro-Lok's superior resiliency also means that its surface can more readily absorb accidental blows without puncturing or ripping the vapor barrier jacket.

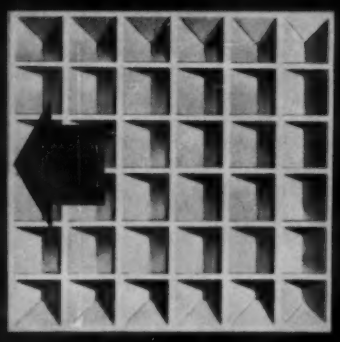
Micro-Lok is highly effective for temperatures from minus 120F to 370F. Made in all standard IP and CT sizes and wall thicknesses, Micro-Lok is available with a wide range of factory-applied jackets including canvas, general purpose and flame-resistant vapor barriers such as the new Flame-Bar. For details, write to J. B. Jobe, Vice-President, Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable: Johnmanvil.

JOHNS-MANVILLE
FIBER GLASS

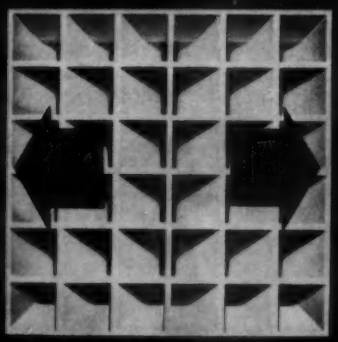
JOHNS-MANVILLE JM PRODUCTS

"I am a Carnes Diffuser Module" (corner throw, actual size)

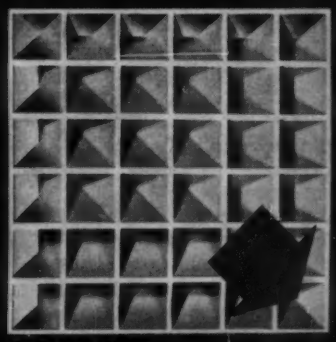




A: 1-way throw



B: 2-way throw



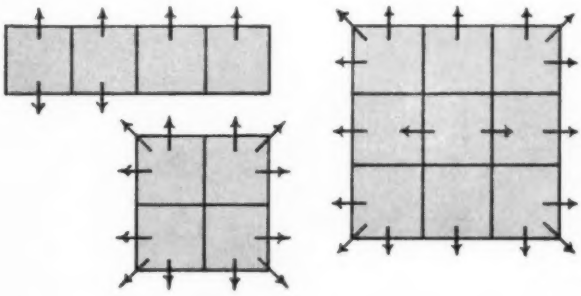
C: Corner Throw

"By combining multiples of my three basic air throw patterns, I can solve almost any air handling problem"

only a CARNES modular diffuser can make these statements

I am unobtrusive My small texture makes me blend inconspicuously with any ceiling material. I fit flush with the ceiling, too, and four of me make a square 12" x 12" — the size of a standard ceiling tile. I have very little see-through.

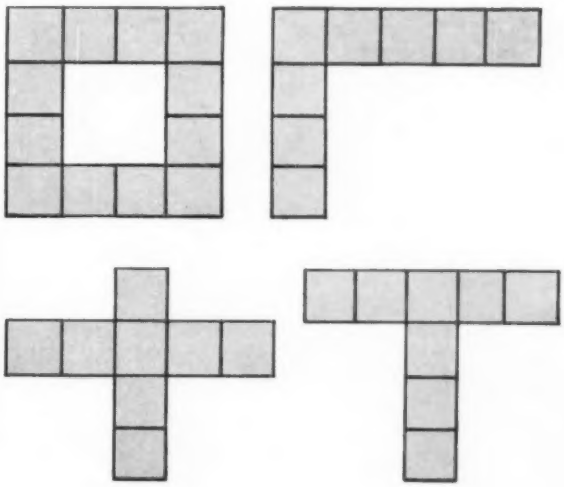
I am versatile By combining any one of my 3 air patterns, shown on the opposite page, I form an infinite number of sizes and shapes, to direct air in 1, 2, 3 or 4 directions for maximum efficiency.



I fit any design My square shape and size (6" x 6") make me an ideal module for any architectural design. Just check the ways I can be used: butted to lights, spacers between lights, alternating line with lights, continuous strips around ceiling coves, along corner windows, around columns.

I am interchangeable Just snap me into my simple frame. I may be easily removed to change direction of air throw made necessary due to rearrangement of occupied areas, or for periodic cleaning.

I make any shape That is, except a circle.



I work with any ceiling Plaster, tile, metal pan, "T" bar, spline — you name it and I have a frame that works efficiently with it. I have a frame to fit any combination of shapes or sizes you want to use me in.

I am tough Carnes makes me out of General Electric's LEXAN® — that's a high impact, fire retardant material with excellent color and dimensional stability. I'll give years and years of service. ®Registered Trade Mark

---

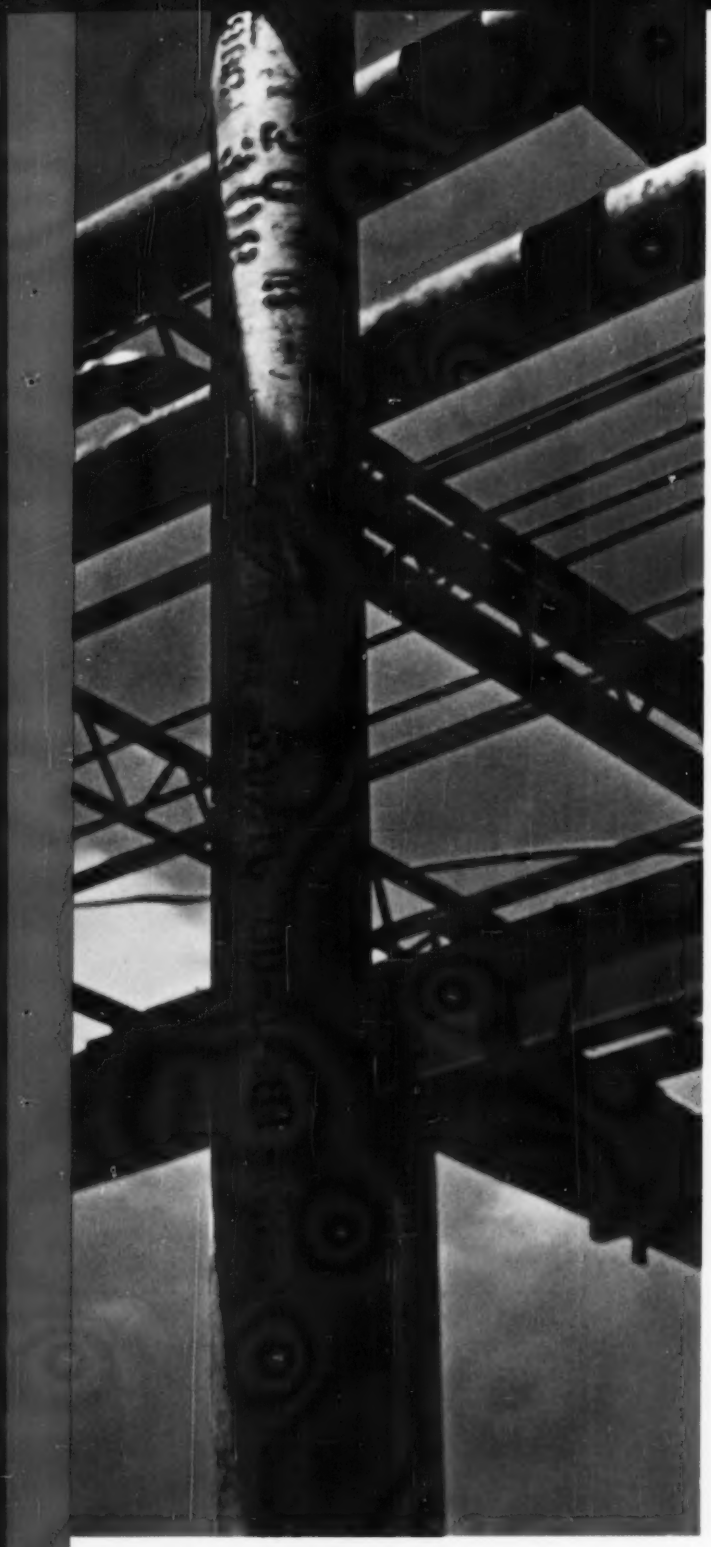
Get more of my intimate details by writing for catalog no. 460

Carnes also manufactures: Round, Rectangular, Square, Convertible and Baseboard Diffusers • High-Velocity ATC Units • Low-Velocity ATC Units • Registers • Grilles • Roof and Wall Ventilators

CARNES CORPORATION, VERONA, WIS

CARNES®

Canadian Subsidiary: Wehr Air Equipment Company, Ltd. Winnipeg, Canada.



STRONG

Youngstown seamless steel pipe for heating, piping and air conditioning . . . built strong to last long

Steel is a building tradition. Steel is strength. Steel is pipe from Youngstown—made strong to build better with, for less. Join length after length, story after story. Run a steam line. Raise water up, drain waste down. Work close. Hug ceilings. Bend, couple, thread. Youngstown seamless pipe is easy to work, line up; fast and simple to connect.

Order Youngstown seamless 2⅜" O.D. to 14" O.D. Get it with ends plain, beveled, threaded and coupled. Try exclusive Yoloy, Youngstown's high strength steel that is up to 6 times more corrosion resistant. Get the size, grade and kind of quality Youngstown steel pipe you need, delivered when you need it, from over 900 reliable pipe distributors.

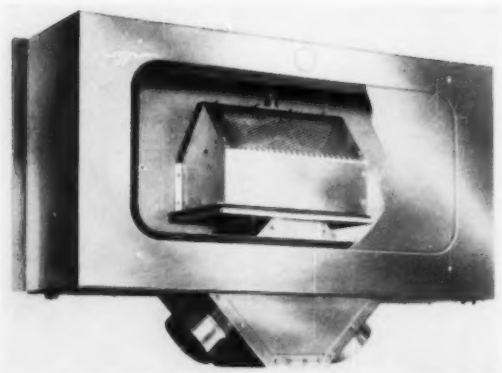
Build better. Build efficiently. Build forever, with steel pipe you can count on—strong seamless steel pipe from the modern mills of Youngstown.

Youngstown – growing force in steel

For full details about Youngstown Seamless Steel Pipe, write: Dept. 19D.
The Youngstown Sheet and Tube Company, Youngstown, Ohio

ingeniously simple...

DUAL DUCT



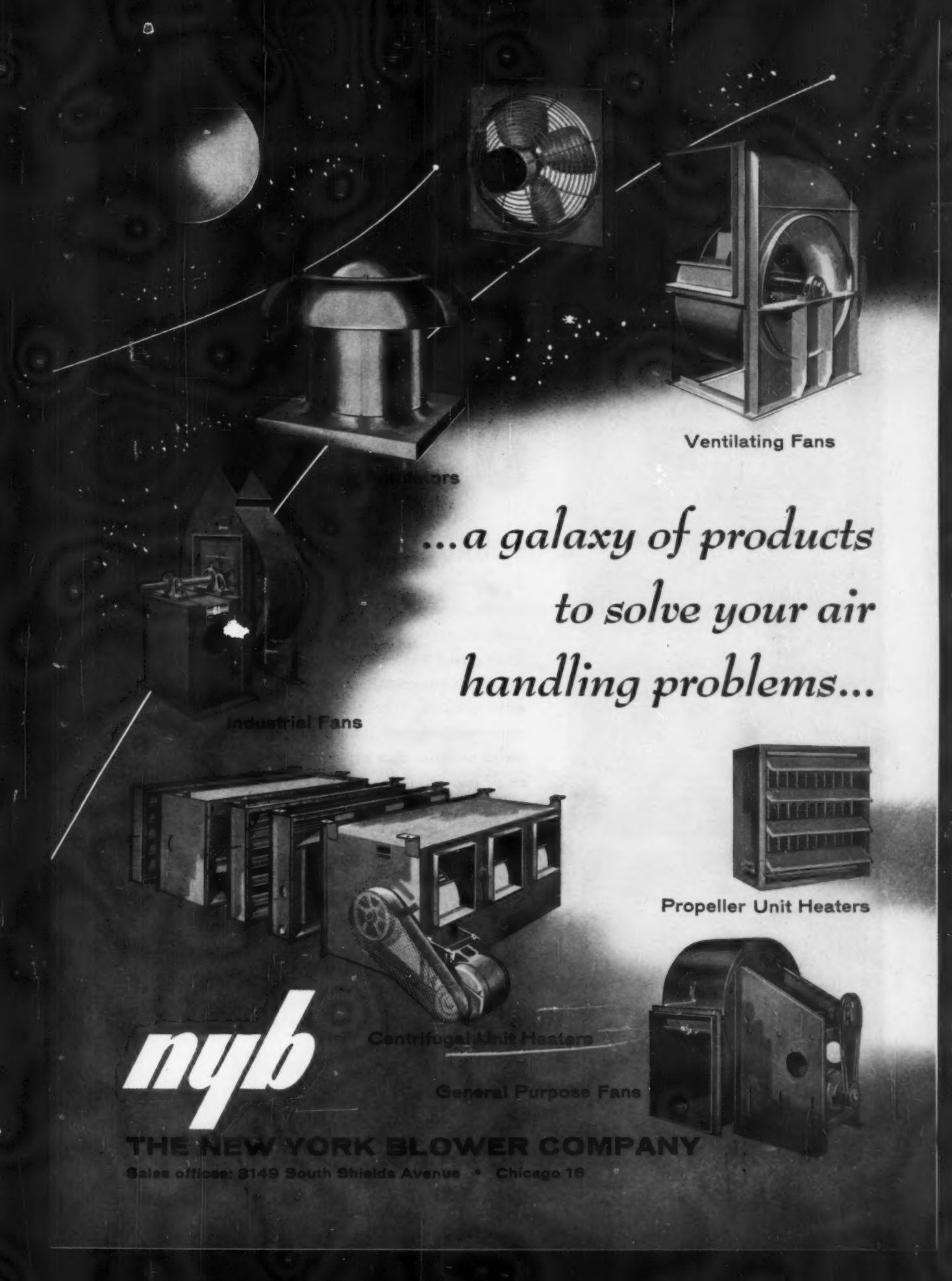
Buensod's unique approach to comfort conditioning multi-zone buildings is shown here. Twenty five years of pioneering this superior method of comfort conditioning has resulted in this simple, foolproof, maintenance-free Dual Duct air mixing unit. From left to right: Buensod-Stacey's famous patented "doghouse," preset at the factory to deliver the specified air volume regardless of pressure variation in the system; the new foam-insulated mixing valve, mounted in enclosure, with greater strength, higher thermal insulation and superior noise attenuation; easily removable access door. It looks simple. It is . . . ingeniously so. Practical, too. Specify Dual-Duct by Buensod for your next new installation or renovation.

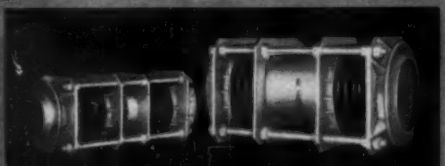
For complete information write for Bulletin DD-6 (HAPC).

BUENSOD-STACEY CORP. · MANUFACTURED PRODUCTS DIVISION

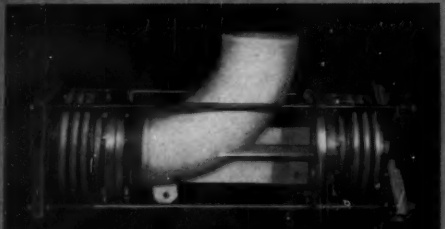
BUENSOD-STACEY

45 West 18th Street · New York 11, N. Y. · Subsidiary of Aeronca Manufacturing Corporation

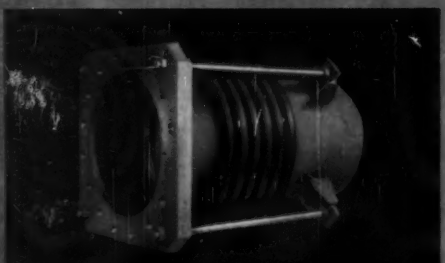

Ventilating Fans
...a galaxy of products
to solve your air
handling problems...
Industrial Fans
Propeller Unit Heaters
Centrifugal Unit Heaters
General Purpose Fans
nyb
THE NEW YORK BLOWER COMPANY
Sales offices: 3149 South Shields Avenue • Chicago 16



This pair of universal expansion joints is installed in the vapor piping of a gaseous diffusion plant. The lines carry Freon 114 at pressures up to 500 psig and temperatures ranging from —20°F to 300°F. Joints accommodate 3" lateral movement under these extremely harsh service conditions.



A 12" pressure balanced elbow assembly specially engineered by Badger for use in LOX storage and transfer facilities at an Air Force Missile Base. The unit is designed to operate at temperatures from —297°F to 250°F — a thermal shock range of nearly 550°! Operating pressures vary from 0 to 150 psig. Joint movement: 0.8" axial, 0.15" lateral.



One of eight specially engineered Badger Expansion Joints at a power plant for a gas recovery unit in Texas. Installation is on a cooling water piping of the surface condensers where service conditions require operation at 55 psig at a temperature of 107°F. The joints are designed to absorb ½" lateral movement in combination with ¼" axial movement.

This 24" x 44½" I.D. rectangular expansion joint, connects the turbine and condenser at a steam power plant. Each of the units is designed to operate at a pressure ranging from full vacuum to 1 psig at a temperature of 360°F. The joint handles ⅜" axial compression and a plus or minus ½" lateral movement.

TOUGH JOINTS

— BADGER SPECIALTY

Anyone with the necessary manufacturing facilities can fabricate expansion joints. But it takes an *experienced* manufacturer to analyze tough piping problems properly and then provide the correct expansion joints to solve them. Badger, with more than 55 years in the field, has had more experience with a wider variety of special design problems than any other expansion joint manufacturer. Put this store of skill and knowledge to work for you — get the most effective and economical solution to your expansion joint problem. Call or write for complete information about Badger S-R Expansion Joints and our "on-the-spot" engineering service.

BADGER
MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASSACHUSETTS

Representatives in Principal Cities

Now RIDGID® Sets The Pace In Tubing Tools, Too!

Long the outstanding quality leader in pipe tools, RIDGID now leads the way in tubing tools. Compare these new RIDGID Tubing Tools with the ones you're now using . . .

Compare them for advanced design . . . quality construction . . . economy. You'll find RIDGID Tubing Tools last longer . . . give the most all 'round value for the money.

Choice of 8 RIDGID Tubing Cutters

For Copper, Brass, Aluminum, Tubing and Thin-Wall Conduit!

RIDGID No. 105 Tubing Cutter
Open or Closed Only 5" Long
Full ⅛" to 1⅛" O.D. Capacity

RIDGID Nos. 10, 15 and 20 Tubing Cutters
Lightweight Aluminum Alloy Frames . . . Fold-in Reamers
No. 10—⅛" to 1" O.D.
No. 15—⅜" to 1⅛" O.D.
No. 20—½" to 2⅛" O.D.

RIDGID No. 205 Tubing Cutter
Fast Slide-to-Size . . . Instant Trigger Release.
⅛" to 2⅝" O.D. Capacity

RIDGID Nos. 30 and 40 Tubing Cutters
Perfect Tracking . . . No Burrs . . . Aluminum Frame.
No. 30—1" to 3" O.D.
No. 40—2" to 4" O.D.

RIDGID No. 315 3-Wheel Tubing Cutter
For Emergency Use Where Full Turn Is Not Possible.
No. 315—⅜" to 1⅛" O.D.

Choice of 3 RIDGID Flaring Tools!

All parts are locked together . . . Automatic feed release . . . Rolling cone action produces smooth, uniform flare walls. 3 models for 45° and 37° S.A.E. flares.

RIDGID No. 457 for 45° flares, ⅛" to ⅝" O.D. (7 sizes)
RIDGID No. 459 for 45° flares, ⅛" to ¾" O.D. (9 sizes)
RIDGID No. 376 for 37° flares, ⅜" to ⅝" O.D. (6 sizes)

SEE, TRY AND BUY THESE RIDGID WORK-SAVER TUBING TOOLS AT YOUR SUPPLY HOUSE!

RIDGID

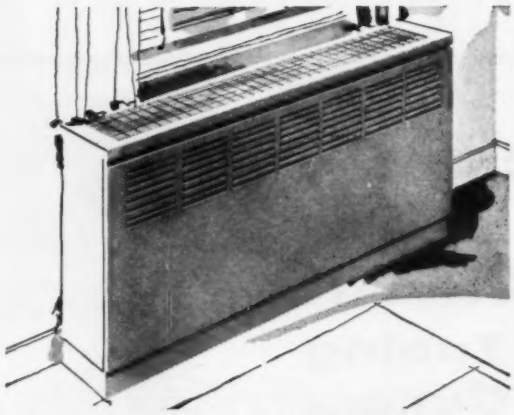
The Ridge Tool Company, Elyria, Ohio, U.S.A.

NEW CARRIER REHEAT WEATHERMASTER SYSTEM

...WHERE and WHY you can use it to advantage!

Now you can capitalize more often on the unique advantages inherent in all single duct, constant volume air conditioning systems with reheat at room terminals. The new Carrier 36BA Reheat Weathermasters* permit use of either high or normal velocity primary air. Four reheat coils are now available in each unit size. And you have a wide selection of new modular cabinets and furred-in arrangements.

You can select units more economically to meet cooling capacity and sound control requirements, with the assurance that they will also be able to match almost any heating load —regardless of geographical location, exterior glass area, or limitations of existing steam or hot water plants. For complete information on the new Carrier Reheat Weathermasters,



write for the 8-page catalog, 36BA86. Carrier Air Conditioning Company, Syracuse 1, N. Y.

WHERE:

Existing office buildings, hospitals and hotels, regardless of size, where present steam and hot water services are in good condition. Units replace radiators; only supply air duct system need be added.

Schools, where high ventilation capacity and ease of automatic room temperature control make this system very suitable. May be applied for heating and ventilating only, with cooling added later at low cost.

Laboratories, where precise control of both humidity and temperature is a requirement.

New small office buildings, where it is usually impractical to apply a high-pressure induction system, yet a quality system at low cost is wanted.

WHY:

All-air cooling assures superior ventilation and odor dilution.

Induction at unit permits smaller ducts, lower fan horsepower, gravity heat.

Constant volume supply air speeds system balancing, maintains constant air motion.

Constant temperature supply air simplifies central station apparatus, provides maximum humidity control.

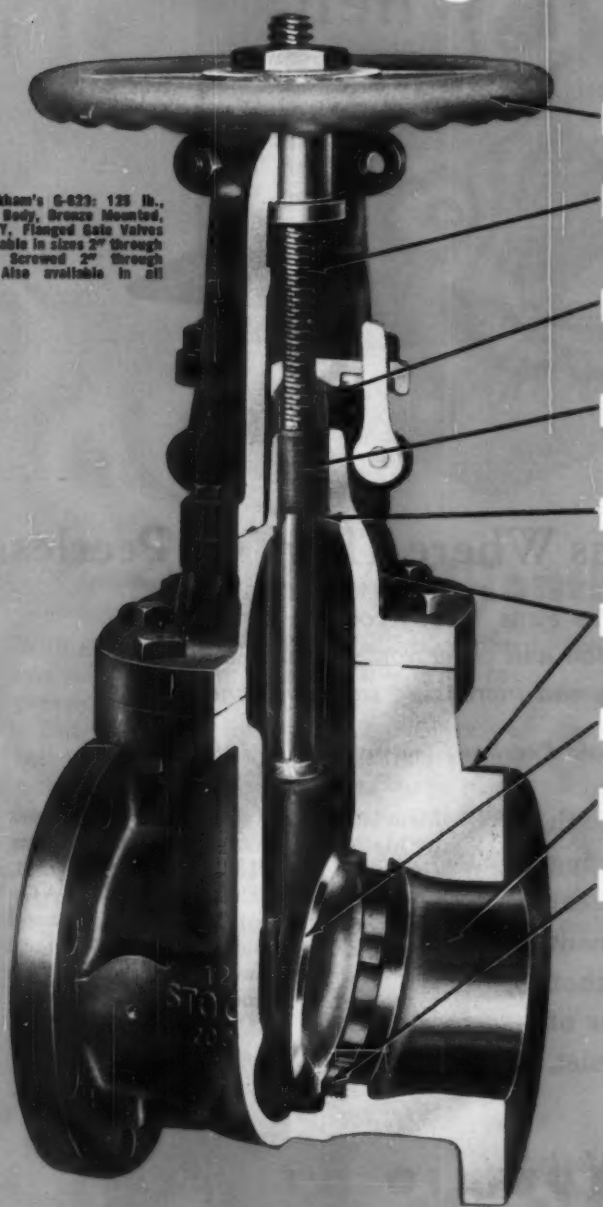
Central station design eliminates service in occupied spaces.

Reheat at unit provides best possible control, solves zoning problems.

Carrier ***Air Conditioning Company***

WORKS BEST... WORKS LONGEST!

FOR 9 GOOD REASONS:



Stockham's G-623: 125 lb., Iron Body, Bronze Mounted, OS&Y, Flanged Gate Valves available in sizes 2" through 24". Screwed 2" through 6". Also available in all iron.

1. Extra large, non-slip HANDWHEEL operates faster, easier.
2. High tensile bronze STEM (minimum tensile 60,000 psi.). Extra large diameter. Heavy Acme stem threads for longer wear.
3. Two piece ball and socket type PACKING GLAND AND GLAND FLANGE absolutely prevents stem binding and assures perfect alignment.
4. Extra deep, completely machined STUFFING BOX accommodates more packing, assures tighter seal and longer packing life.
5. Screwed in bronze REPACKING SEAT BUSHING guides stem throughout travel. Can be repacked in full open position.
6. Semi-steel BODY and BONNET features uniform heavy wall thickness to resist line-strain distortion.
7. Completely-guided DISC eliminates wear of both disc and seat rings for longer, tighter seal.
8. Smooth FLOW LINES prevent turbulence and pressure drop. Assures 100% flow.
9. Buttress-type SEAT RINGS will not loosen in service, prevent sediment accumulations — superior to flanged-type design.

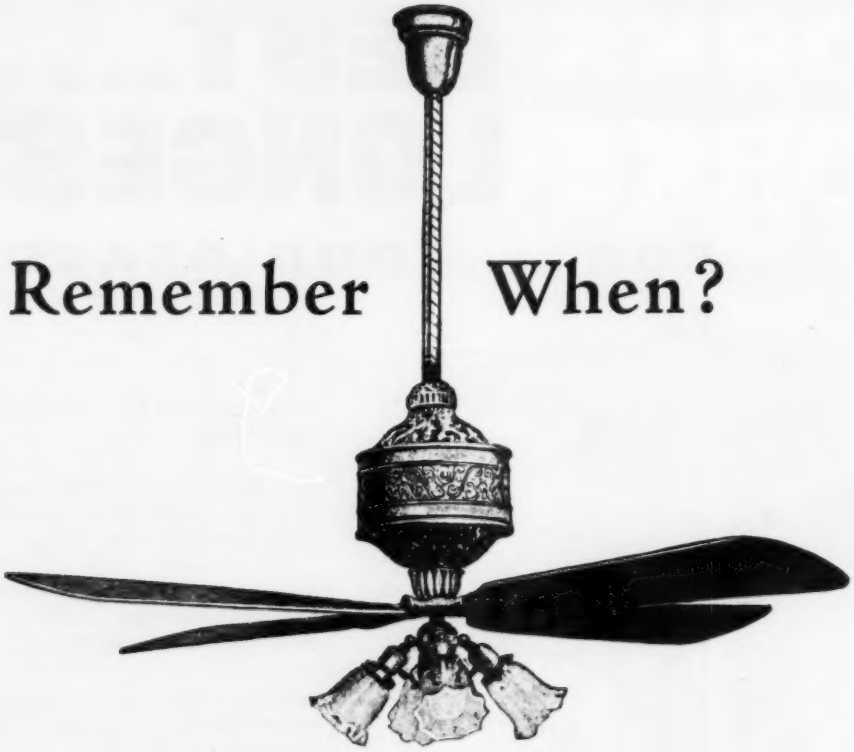
You pay no more for these superior Stockham design features that assure dependability and low maintenance cost. Specify Stockham for all your valve and fitting needs — America's only complete line. For further information call your local Stockham distributor, or write:

AVAILABLE THROUGH YOUR LOCAL STOCKHAM DISTRIBUTOR

Bronze, Cast Iron, Ductile Iron, Cast and Forged Steel Valves—Wedgeplug Non-Lubricated Plug Valves—Cast Iron, Malleable and Ductile Iron Pipe Fittings.

STOCKHAM
VALVES *and* FITTINGS

General Offices and Plant
4000 North 10th Ave. • Birmingham, Alabama



Remember When?

"You Can't be Cheerless Where There's a Peerless"

"If you're a fan user, Peerless Fans steady cooling current and its noiseless, reliable operation will cheer you. If you're a supply dealer, Peerless Fans steady and increasing sales will cheer you."

This headline and copy sold Peerless Electric Fans in 1907.

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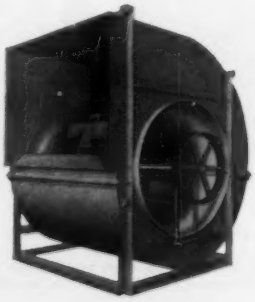

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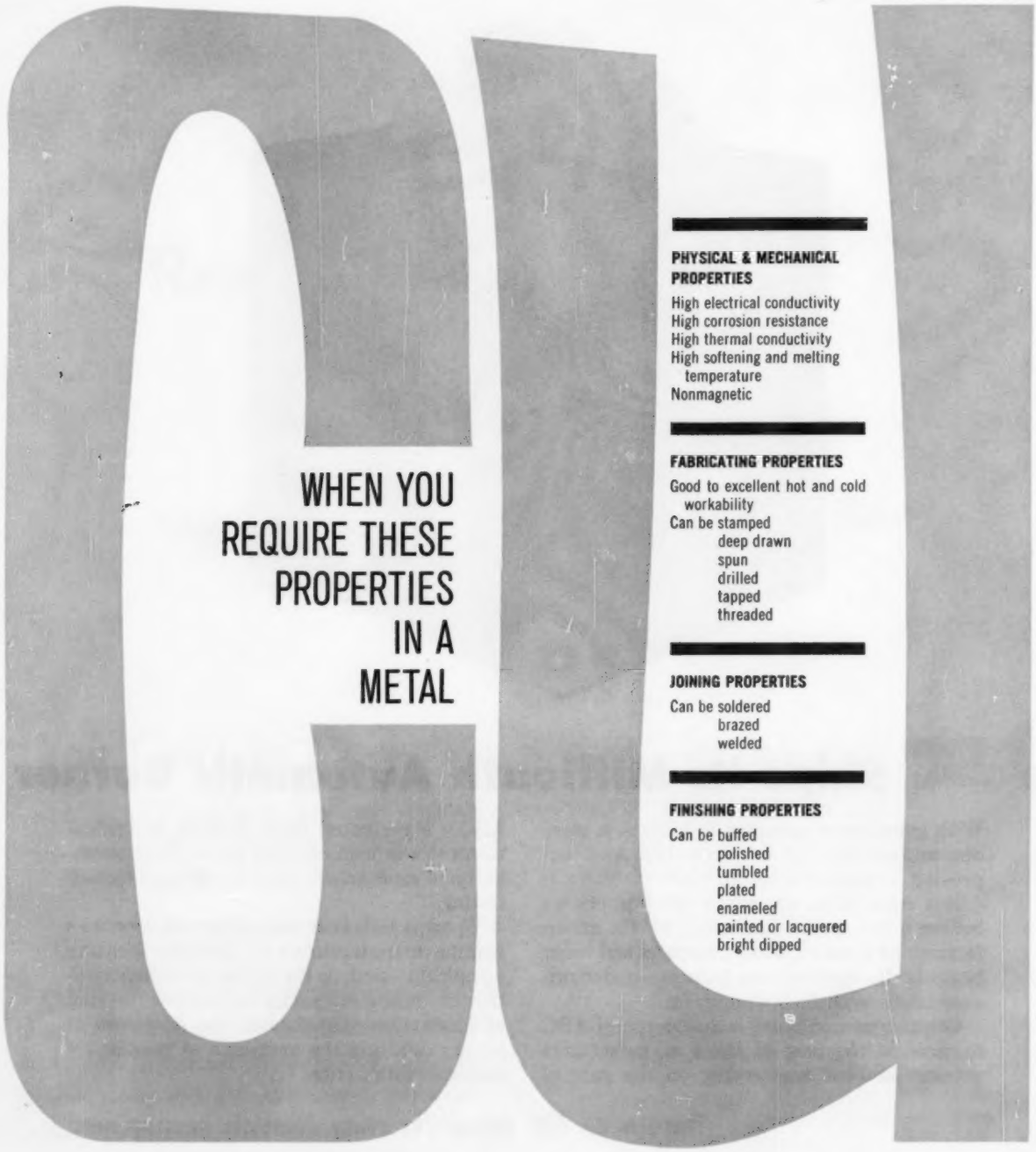

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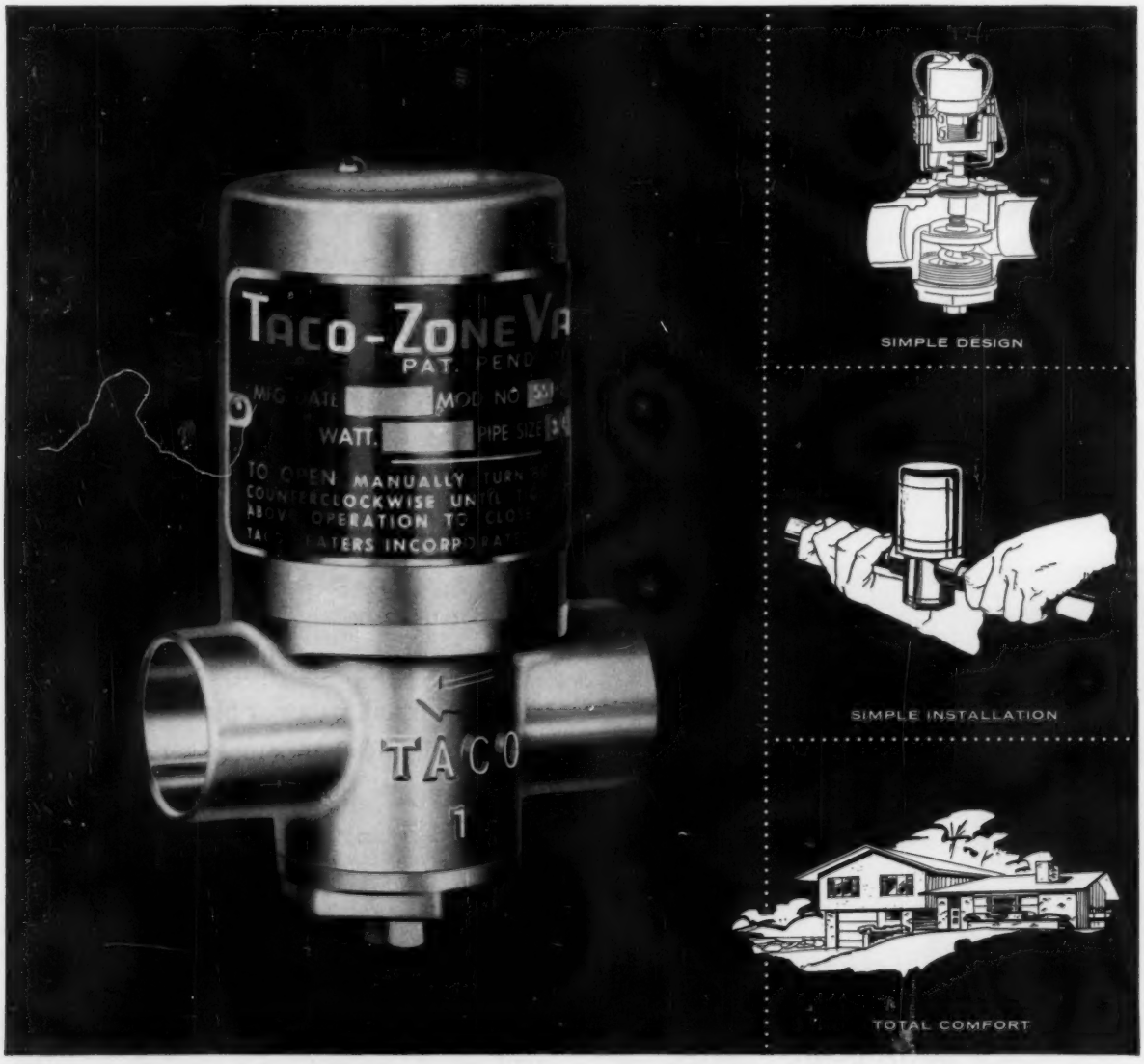

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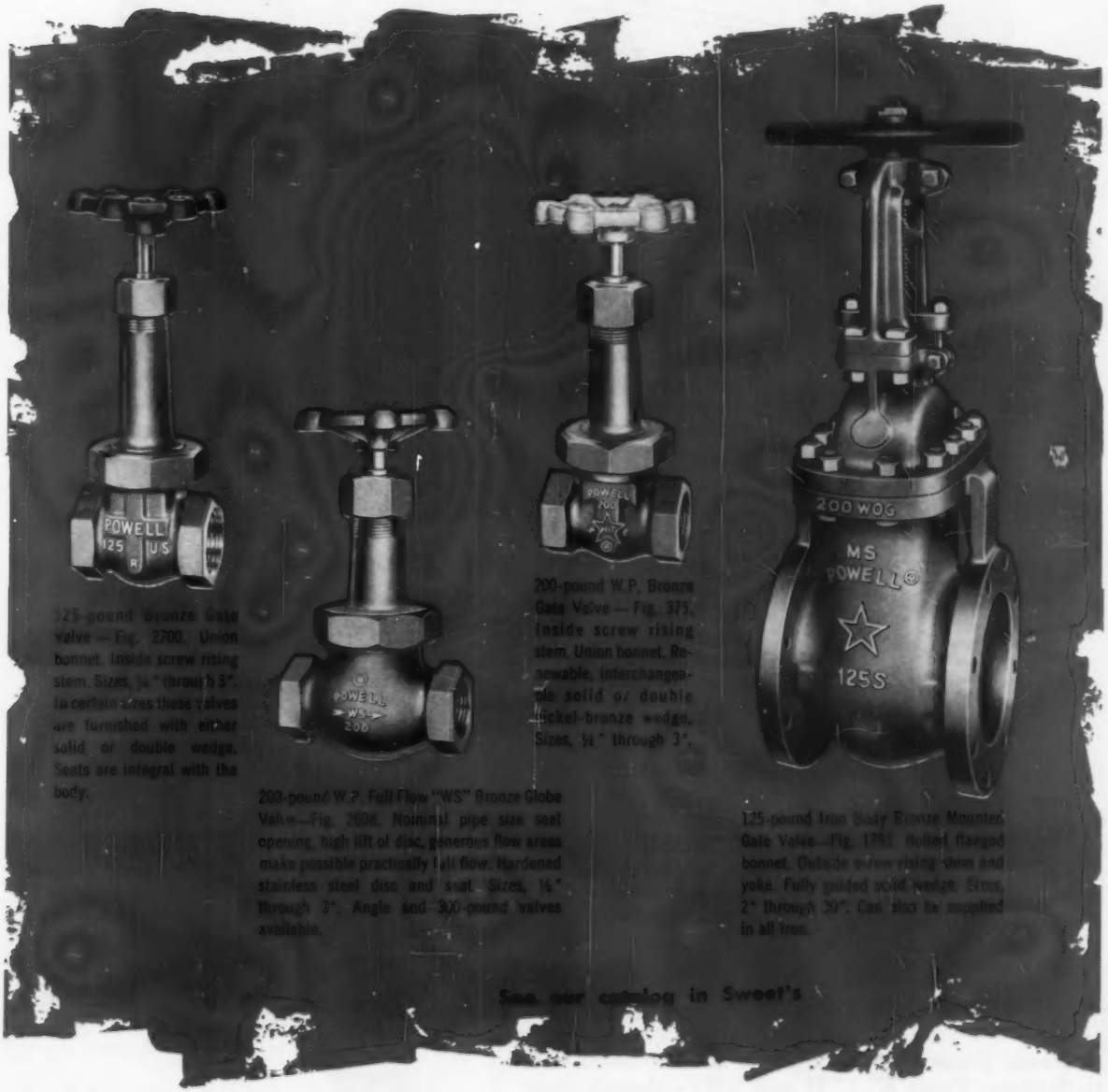

125-pound Bronze Gate Valve — Fig. 2200. Union bonnet. Inside screw rising stem. Sizes, ¼" through 3". In certain sizes these valves are furnished with either solid or double wedge. Seats are integral with the body.

200-pound W.P. Full Flow "WS" Bronze Globe Valve—Fig. 2608. Nominal pipe size seat opening, high lift of disc, generous flow areas make possible practically full flow. Hardened stainless steel disc and seat. Sizes, ¼" through 3". Angle and 300-pound valves available.

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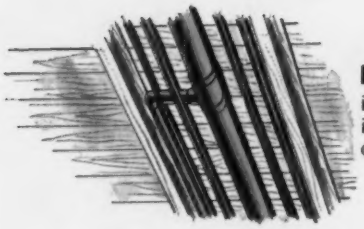

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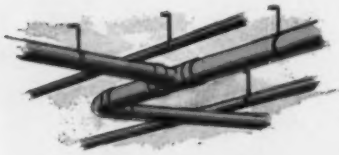
it can be quickly installed between original floor joists

BECAUSE
risers can be installed in original stud spaces



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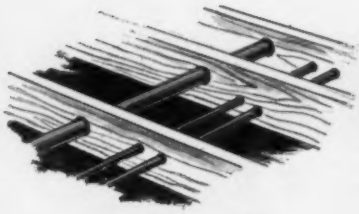
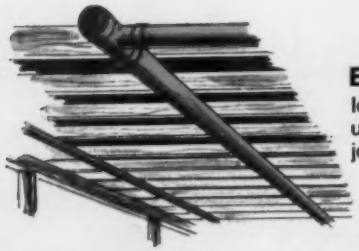
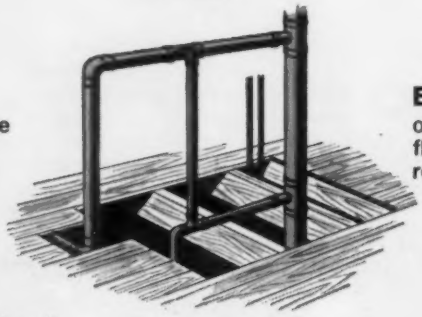


BECAUSE
it can be fitted through small holes in old joists



BECAUSE
long lengths can be used with fewer joint connections



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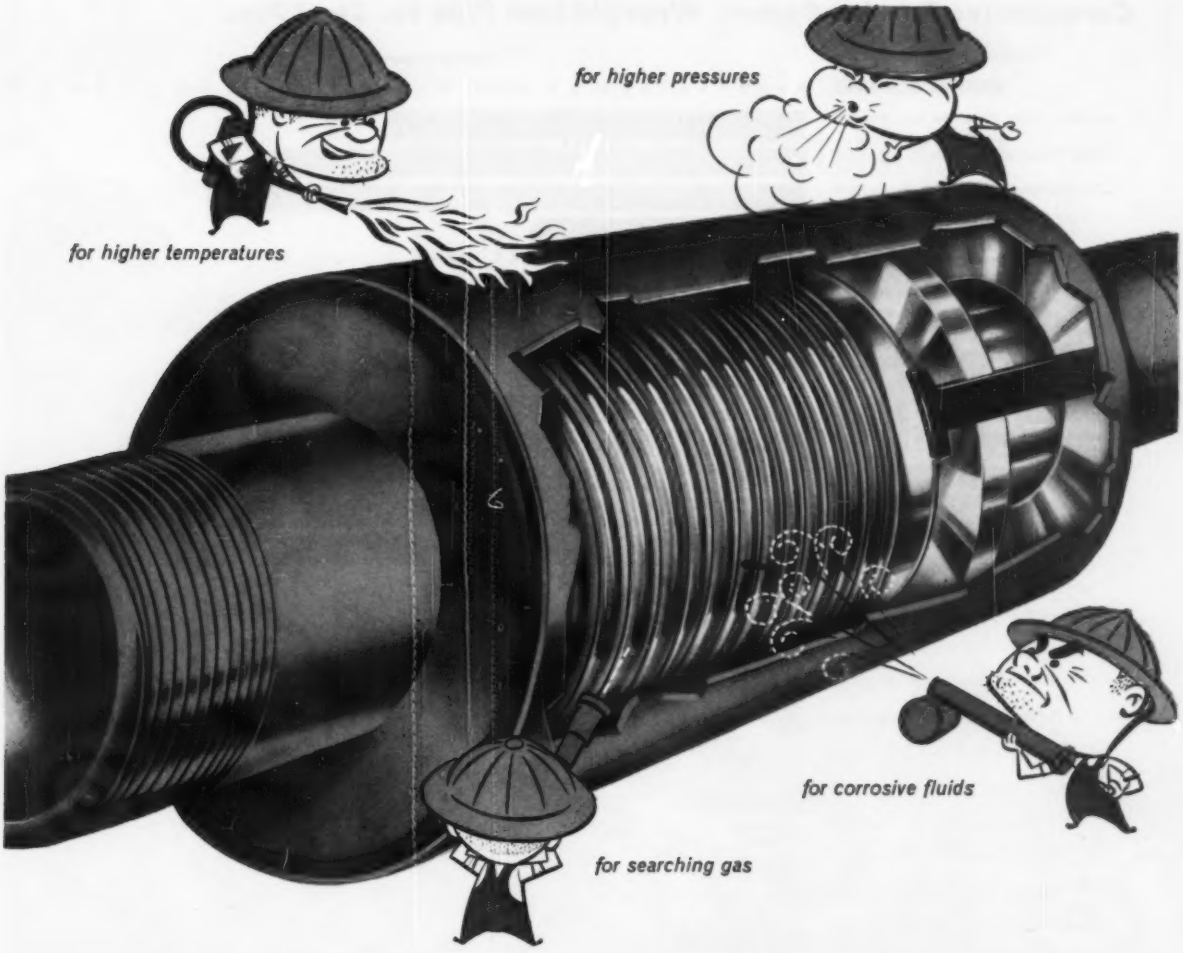

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Another important *first* from Flexonics! The original high-pressure, heavy-duty Expansion Compensator is now available entirely of stainless steel—to handle pipe expansion under conditions of higher pressure, higher temperature, corrosive fluids, chemicals and gases.

Screwed, welding, or flanged ends; heavy-duty two-ply Flexonics bellows; positive anti-torque design; and protective shroud . . . all are of stainless steel, to absorb up to 2″ pipe expansion under corrosive conditions, at working pressures up to 175 p.s.i., temperatures up to 750°F. Pipe sizes ¾″ to 3″.

Inch for inch, this is your simplest, lowest-cost way to take up pipe motion under difficult operating conditions. Completely packless, it never needs maintenance. Designed to outlast the piping system you install it in. Also Model H—carbon steel construction with stainless steel bellows; and Model HB—all bronze.

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Comparative Service Report: Wrought Iron Pipe vs. Steel Pipe

Ice Rink Survey Identification
Years of Service
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
WROUGHT IRON RINKS
1. Rockefeller Center Plaza, New York, New York
2. Baker Memorial Rink, Princeton, New Jersey
*3. Duquesne Gardens, Pittsburgh, Pennsylvania
†4. Iceland Rink, Akron, Ohio
5. Madison Square Garden, New York, New York
6. Madison Square Garden, New York, New York
7. U.S. Military Academy, West Point, New York
8. Philadelphia Arena, Philadelphia, Pennsylvania
9. New York City Building, New York, New York
10. Hershey Sports Arena, Hershey, Pennsylvania
11. Chicago Stadium, Chicago, Illinois
12. Playland Skating Rink, Rye, New York
13. Utica Curling Rink, Utica, New York
STEEL RINKS
14. Madison Square Garden, New York, New York
15. Hershey Sports Arena, Hershey, Pennsylvania
16. Chicago Stadium, Chicago, Illinois
17. Rhode Island Auditorium, Providence, Rhode Island
18. Boston Gardens, Boston, Massachusetts
19. New Haven Arena, New Haven, Connecticut
20. Tulsa Coliseum, Tulsa, Oklahoma
21. Boston Arena, Boston, Massachusetts
22. Olympic Arena, Lake Placid, New York
23. Philadelphia Arena, Philadelphia, Pennsylvania
24. University of Illinois, Urbana, Illinois
25. U.S. Military Academy, West Point, New York
26. Civic Auditorium, Seattle, Washington
Years before first failure
No failure to date
*Razed in 1956. †Converted into roller rink, 1952.

Keep ice rink piping performance out of the red: Use corrosion-resistant Wrought Iron

Random sampling of 26 ice skating rinks (see above graph) provides authoritative documentation of Wrought Iron's superiority over steel. Figures indicate Wrought Iron outlasts steel better than 4 to 1.

In eight of the rinks, the original rink piping, as well as all replacement piping, was steel. Five of the installations were originally piped with steel, but have since been repiped with Wrought Iron. The remaining installations have used only Wrought Iron pipe.

Not one of the thirteen rinks originally piped with steel operated for more than seven years before piping failures occurred. Average life before failure: only four years. And six of these rinks experienced their first pipe failures in three years or less.

Contrast this service record with that of the rinks piped with Wrought Iron . . . most of them are still going strong. Average uninterrupted service life of the Wrought Iron piped rinks is 19.9 years—with many more years of life still to come.

Write for the complete report: *Ice Skating Rinks—Their Construction and Maintenance*. A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.

A. M. BYERS COMPANY

PIPE PRODUCTS: Wrought Iron • PVC • Steel
ROLLED PRODUCTS: Plates, Billets and Bars
Wrought Iron, Stainless and Alloy Steel

. . . I can get just the fin spacing, tonnage and CFM I want."

Now, Halstead & Mitchell gives you a choice of 6, 7, 8 or 10 fins per inch . . . makes it much easier to match a central fan-coil unit to a particular job or to meet specifications.

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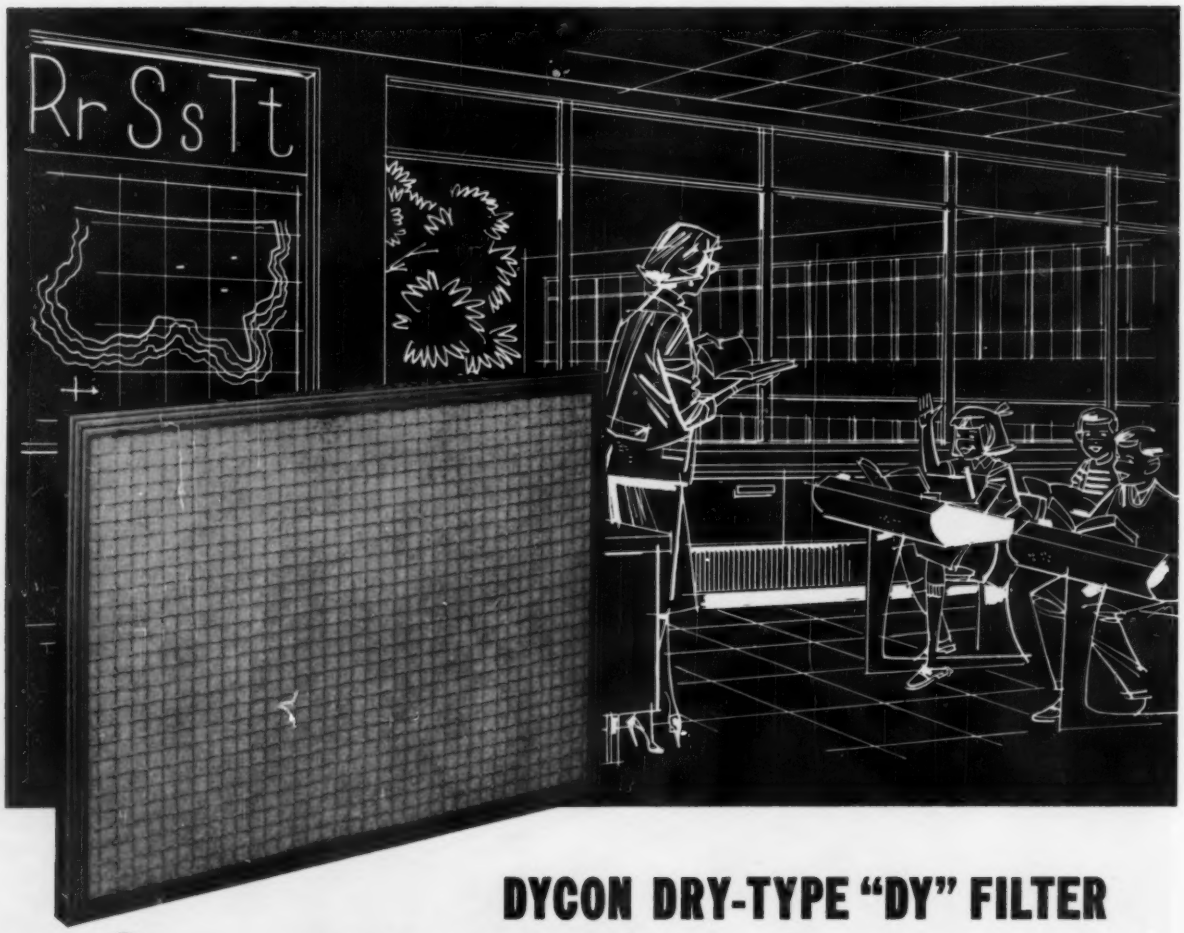

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- **VARIETY OF SIZES** — Filters can be made in special sizes to fit your application in thicknesses either ½" (actual 7/16") or 1" (actual ⅞") or any rectangular or square shapes from 4" x 4" up!
- **SAFETY** — Listed by Underwriters' Laboratories in Class 2!
- **PRECISION BUILT** — Width and length tolerances plus nothing minus 1/16"; thicknesses plus or minus .010"!
- **RUST AND CORROSION RESISTANT** — Alloy 3003 aluminum (frame), hot dipped galvanized steel (face guards), and durable — stable Dycon (media)!
- **LOW, LOW COST** — Even special sizes can be competitive with cheapest non-permanent air filters.
- **CONVENIENCE** — You can have a "new set" of filters whenever necessary right on your own job after you install Type "DY" Dycon permanent type air filters!
- **LIGHT WEIGHT** — Barely heavier than cheapest non-permanent filters!

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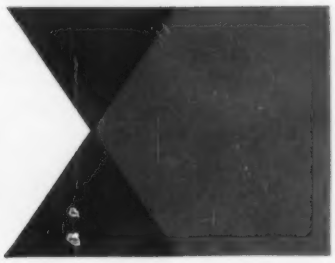
We follow here each month the practice at engineering society meetings of providing an "open for discussion" period. You are urged to take part. Just address your comments to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.



"Open for Discussion"

Low Level Distribution Makes Sense For Industrial Ventilation

THE ARTICLE *Industrial Ventilation Can Be More Effective and Cost Less* in the November issue is very informative because of the interesting cost comparison between a conventional system and the "proposed" system, and because of the weather and effective temperature data given in Figs. 3 and 4. These do indeed show clearly that good design, resulting in better performance, need not cost more but can in fact cost much less.

It is interesting to see how more and more engineers are discovering that an effective job of cooling or relief in industrial areas can only be done when the air is delivered to the work zone. Specifically, for the installation summarized in Table 1 of the article, 2 cfm per sq ft are doing the job of 6.28 cfm per sq ft for an ordinary installation provided with high level outlets. A large number of similar systems having low level distribution are successfully proving the point throughout industry.

In the illustrations, there are a number of items worthy of note. With low level distribution and adequate exhaust in a high ceiling building, only the internal plant heat load is of importance in maintaining desirable conditions in the building. Wall and roof transmission heat loads are swept out of the building and never reach the work area. Even the temperature rise caused by the plant load occurs above the working level. For these reasons, the low level distribution of the supply air at 2 cfm per sq ft can maintain the work area within 1 or 2 F of the supply air temperature.

None of the foregoing is intended to imply that higher outdoor temperatures are of no concern. Obviously they cause higher space temperatures for straight ventilation and usually do so for evaporatively cooled systems. They also cause higher cooling loads for mechanical cooling systems. But the point is that for any given outside condition the low level distribution system can do a more effective job of work space temperature control.

There is nothing magical about the quantity 2 cfm per sq ft for ventilation. In many industrial areas the makeup air required for dust and fume removal will set the ventilation rate. This may be 15 cfm per sq ft or higher. It has been found, however, that this 2 cfm per sq ft will do an excellent job in many plants having high equipment heat loads, where the supply system is properly designed and no localized or unusual sources of radiant or other heat exist.

Rules of Thumb Won't Do

It should also be apparent from the article that the old rule of thumb figures of air change and temperature rise are meaningless for the design of effective industrial ventilation and air conditioning systems. Again we must keep in mind that our concern is with the work zones.

We are not concerned with the temperature under the roof if adequate exhaust is provided to prevent a "build up" of the layers of heated air. In the example cited in the article, with an internal heat load of 125 Btu per sq ft and ventilation at 2 cfm per sq ft, the temperature rise would be about 57 F. For a 20 ft ceiling height, the air change rate would be 10 minutes, or six air changes per hr. This is a long way

"Open for Discussion"

Continued

from such rule of thumb ventilation figures as a 5 to 7 F temperature rise, or a one to five minute air change rate (60 to 12 changes per hr).

This article is a fine illustration of what can be done to provide good industrial environments by good air distribution and cooling design. Let's have more like it.

JOHN H. CLARKE
Engineering Design Supervisor
Air Conditioning and Power
The Visking Co.
Div. of Union Carbide Corp.

Points Up Need for True Electric Heat Cost Analyses

THE HPAC ENGINEERING DATA FILE in the September issue on the subject of electric space heating is of great interest. This is indeed a fine discussion on this subject, one which does credit to you and your magazine. It is particularly gratifying to know that you plan a second report in the near future on this subject of electric resistance heating. Specific reliable information on electric resistance heating design is needed by many engineers.

In this article it is stated that the economics of electric resistance heating versus flame fuel systems play a very important part in influencing the choice of heating systems. It is essential to have an accurate analysis of both systems which must include the first cost, the operating cost, and the owning cost of the different systems under consideration. In our experience we have found very few consulting engineers who are able to make such an analysis. All too often they do not get reasonably accurate first costs, including the cost of installation, a reasonable estimate on maintenance from competent sources, or accurate operating costs based on a thorough understanding of the rates and cost of the various fuels involved.

They do not know how to convert figures for heat pump operation or electric resistance heating into accurate equivalent figures for fossil fuels. They do not understand the application of different electric rates pertaining to electric heating or special rates pertaining to fossil fuel heating.

These analyses require a great deal of time — time which most engineers are not willing or able to give to this matter; as in most cases they do not get paid extra for this work. A good analysis requires an engineer's knowledge and time as much as his drawings and he should be paid an extra fee for this work.

Some engineers when considering competitive designs between electric resistance heating and fossil fuel systems think in terms of replacing the fossil fuel heat source with electric resistance coils, with the rest of the design being the same. This is a serious mistake, as the special advantages in using electricity, which you discuss in your report are not being utilized.

Continued on page 76

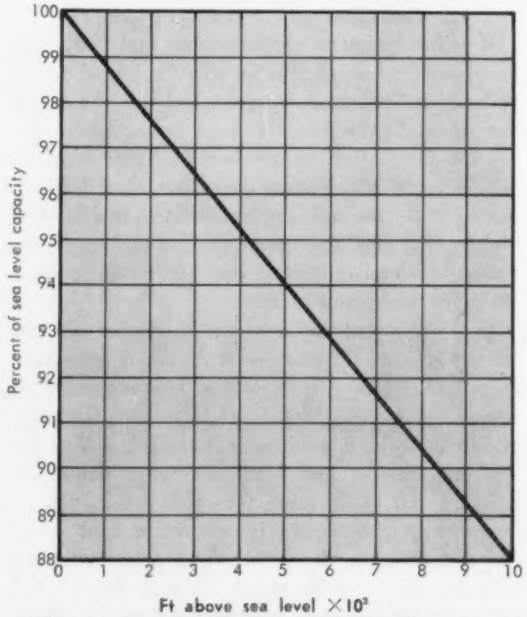
Questions Statement on Enthalpy Of Air at High Altitude

I HAVE READ the article *How Does Altitude Affect Performance of Heating and Air Conditioning Equipment?* in the August issue and I would like to question the point about the 16 percent increase in enthalpy of air at an elevation of 5000 ft mentioned in the article. According to the new fan coil test code about to be released by ARI, this figure would be closer to 10 percent. Therefore, fan speed must be increased substantially to offset the reduced mass flow of 20 percent (which really is more like 17 percent) in order to maintain sea level capacity.

One of the items discussed at this Forum in Denver was the effects of altitude on the performance of convector heating equipment. The enclosed graph is a plot of correction factors which we apply to our equipment based partially on test and partially on theory. I know of no research which has measured the effects of altitude on convector capacity.

I hope these comments are helpful.

E. SARTAIN
Laboratory Supervisor
Modine Manufacturing Co.



CORRECTION FACTORS to apply to rated capacities of convector heating equipment units to compensate for increases in installation altitude above sea level

A better way to make heat

PETRO-PAC

STEAM OR HOT WATER

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SEALED COMBUSTION

No smoke or soot. Cuts standby loss to practically nothing.

PRESSURIZED

No stack—vent only. No flame pulsation. Low electric power requirement.

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No refractory maintenance. Low fuel cost. Combustion efficiency 80% or better.

Real, top-grade, season-long efficiency can only be achieved by *precision* control of the entire combustion process. The whole combustion system is sealed, clear through to the exhaust vent. No draft regulator; no unreliable natural draft; no air infiltration; no dissipation of boiler heat during off periods. The only air admitted is *metered* air. New, unique burner design reaches maximum heat output, without smoke or soot, within a half-dozen seconds. Rear furnace is surrounded by water, preventing heat loss and gas leakage, and avoiding the expense of refractory maintenance. Each pass of tubes terminates in a separate tube sheet to minimize stresses of expansion and contraction. The Petro-Pac is a thoroughly engineered unit, built for exceptional fuel economy, low upkeep, minimum supervision and long life.

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"Open for Discussion"

Continued

One of the most important considerations in making analyses is the fundamental question of the overall operating utilization efficiency of flame heating systems versus electric resistance heating systems or pump systems. Information on this subject is badly needed. We have begun to make such tests using accurate metered electric resistance heating installations compared to similar installations using flame fuel heating. More research should be done on this subject. Until we can know how many kilowatt hours of electricity are equal to how many therms of fossil fuels, all analyses will suffer.

Our research indicates that the overall annual efficiency of fossil fuels, relative to electric resistance heating, is on the order of 40 percent. This is about half of the figure used by many engineers which they secure from the ASHRAE *Guide*. The truth is that flame fuel systems are far more inefficient than is generally realized.

In figuring operating costs, both electric and fossil fuel, we have a method that gives excellent results. We can usually find a building very similar in design to the building under consideration that is located in the same town as the new building. With the owner's permission we secure the cost of heating this building, as well as the amount of flame fuel or electricity used. Heating requirements of two buildings are roughly proportional if their areas are within 15 percent of each other. We prorate the figures of the actual building over to the new building and make a calculation based on this information. By using the above overall annual coefficients of utilization figures we are able to get quite accurate comparative cost information, often within 5 percent. This method does involve more work than some other methods, but the accuracy is correspondingly greater. Consulting engineers would do well to request the advice and services of the local utilities in the area in which the building which they are designing is located.

Many engineers do not realize that heating demands, when using electricity, do not add directly to the basic load of the building. The maximum heating demand does not occur at the same time that the maximum demand occurs on the basic load. It is not always understood that an instantaneous maximum load is not the same as a 30 minute integrated maximum demand. This demand is considerably less than the instantaneous maximum load.

It is not always realized that the wiring for electric resistance heating is not all chargeable to heating, as the same wiring is usable by the air conditioning system.

Many engineers forget to include the cost of the electrical part of flame fuel systems when they make cost comparisons. The electrical cost is quite often a large part of the total cost of flame fuel heating systems.

I particularly like your comments about the necessity of including the total project cost in arriving at good economic comparisons.

In your example of the savings that must be made in the initial cost to justify electric heating you use an overall utilization efficiency of 70 percent. Our tests show that this figure is approximately 40 percent instead of 70. If this 40 percent is used it will make a lot of difference in the result. This is another example of the crucial importance of this overall utilization coefficient for flame fuel.

I particularly like your discussion of "When electric heating should be considered" and "Some points to observe in design." All in all, this is an excellent article; one that has been long needed.

HARRY T. YOPP
Supervisor
Commercial Heating & Air Conditioning
Georgia Power Co.

Good Idea, Good Comments, But Job Goes to Someone Else

THANK YOU for publishing the answers to my question, *What Are the Use Limits on a One-Fan Supply Exhaust System?* (Question of the Month) in the November issue. Mr. Marshall's answer was good, but I think building security should be maintained regardless of air pressures. I do not know of a double fan system capable of controlling pressure to 0.01 in. WG. Stack effect, wind effect, weather conditions, filter loading, and damper hysteresis all prevent such accurate control. Mr. Bible's inclusive answer was excellent.

On a recent job where I used the system under discussion, I lost an architect-client because the city of Chicago does not allow such a system in its building code. Their contention was that 1) rooms requiring relief openings should have a separate relief opening up through the roof, 2) all air systems should be made of sheet metal, and 3) floor diffusers or registers are unsanitary.

I learned one valuable lesson — no matter how ingenious a designer is, or how sound his engineering thinking, he must check the codes.

PHILIP J. BISESI
Air Conditioning Engineer

More Data on University Air Conditioning Operating Costs

MUCH INTEREST has been exhibited in my article *University Air Conditioning Costs Revealed by SMU Utility Analysis* which was published in your October

Continued on page 78

The key to school air conditioning is in your hands...

Changing educational patterns demand flexible schools with learning spaces equipped for year-round air conditioning under unitary control— as an economic necessity based upon educational productivity for the life of the building.

New schools need air conditioning.
To produce the quality and quantity of education required in the future, school buildings must be free of the excess heat that shackles learning in many of the nation's classrooms from early spring to late fall.
School people know this; but some of them are inhibited by public opinion or by the notion that an air-conditioned school must be an inartistic box.
It is largely up to you to correct these impressions . . . by explaining how air conditioning eliminates the greatest physical threat to learning, and by showing how it frees school architecture from old clichés and permits you to meet the educational specifications with originality and economy.
As you know, a renaissance in school design is already under way, stimulated by the need for controlled environment schools— and Nesbitt *Year-Round* Unit Ventilators are being widely employed as the preferred equipment for all-season thermal comfort in every learning space.
Nesbitt can help you to explain the importance of school air conditioning with slide films, case studies, cost data, publications, and other services.

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"Open for Discussion"

Continued

issue. Since the article was prepared, we have added 17 watt-hour meters for the electric auxiliaries and six water meters to measure the makeup water used by the cooling towers. This instrumentation was installed in April 1961 so the results shown in Table 3 of the October article include the detailed results only for the months of May and June.

I did not attempt to show the water used as I had no information for the first 10 months of the study. The cost of electric auxiliaries for the first 10 months was necessarily estimated. In order to make the data for steam and electric systems more complete, I have prepared a detailed tabulation of the costs for July and August, including metered electric auxiliaries and makeup water for both systems. Summary costs are given in Table 1 wherein costs in section *B* are based upon our average electric and gas rates (0.885¢ per kwh, 21.57¢ per 1000 cu ft).

Compensate for Low-Rate Situation

While it is true that our method of operation enables us to use "off peak" electric energy most of the time, we feel that to base cost of operation on such a low unit cost as this would be misleading. For those who are particularly interested in analyzing this in more depth though, I have included section *C* in Table 1, which gives incremental air conditioning costs. The costs in section *C* are based upon incremental electric energy in the lowest step of the rate, 0.48¢ per kwh, and the lowest step in the gas rate, 17¢ per 1000 cu ft.

DAVID C. PFEIFFER
Professor of Mechanical Engineering
Director of Physical Plant
Southern Methodist University

TABLE 1 — SUMMARY of air conditioning costs at Southern Methodist University, Dallas, Texas during July and August 1961 is given here for two electric and gas rates. In section *B*, unit costs are computed with average electric and gas rates based upon usage for all purposes. In section *C*, costs are based upon lowest rate in structure for respective energy source and represent incremental costs for air conditioning

	July		August	
A. Operating data				
1) Electric system				
Ton hours produced	177,475		191,215	
Energy for refrigeration, kwh	164,400		181,800	
Energy for auxiliaries, kwh	21,559		26,752	
Makeup water, gal	339,500		411,600	
2) Steam system				
Ton hours produced	561,807		539,636	
Steam consumed, lb	10,210,000		10,540,000	
Energy for auxiliaries, kwh	96,073		92,850	
Makeup water, gal	2,561,000		2,071,800	
B. Costs based upon average electric and gas rates				
1) Electric system	Total, $	Unit, cents per ton-hour	Total, $	Unit, cents per ton-hour
Refrigeration	1367.00	0.770	1501.00	0.784
Auxiliaries	179.00	0.101	221.00	0.116
Water	102.00	0.057	123.00	0.064
Totals	1648.00	0.928	1845.00	0.964
2) Steam system				
Refrigeration	3023.00	0.538	2989.00	0.533
Auxiliaries	799.00	0.142	766.00	0.142
Water	769.00	0.137	621.00	0.115
Totals	4591.00	0.817	4376.00	0.810
C. Incremental costs based upon lowest rate in respective rate structure				
1) *Electric system*				
Refrigeration	789.00	0.445	873.00	0.457
Auxiliaries	103.00	0.058	128.00	0.067
Water	102.00	0.057	123.00	0.064
Totals	994.00	0.560	1124.00	0.588
2) *Steam system*				
Refrigeration	2086.00	0.371	2169.00	0.402
Auxiliaries	461.00	0.082	446.00	0.083
Water	769.00	0.137	621.00	0.115
Totals	3316.00	0.590	3236.00	0.600

how to control temperatures with gas unit heaters

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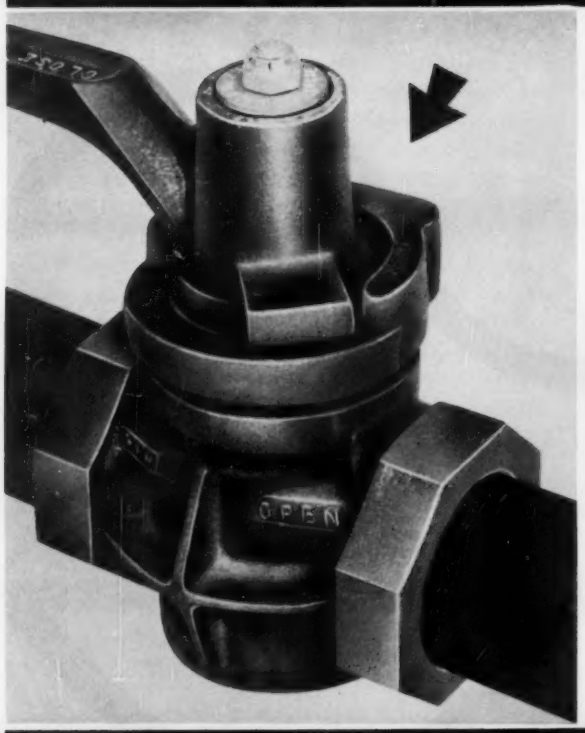

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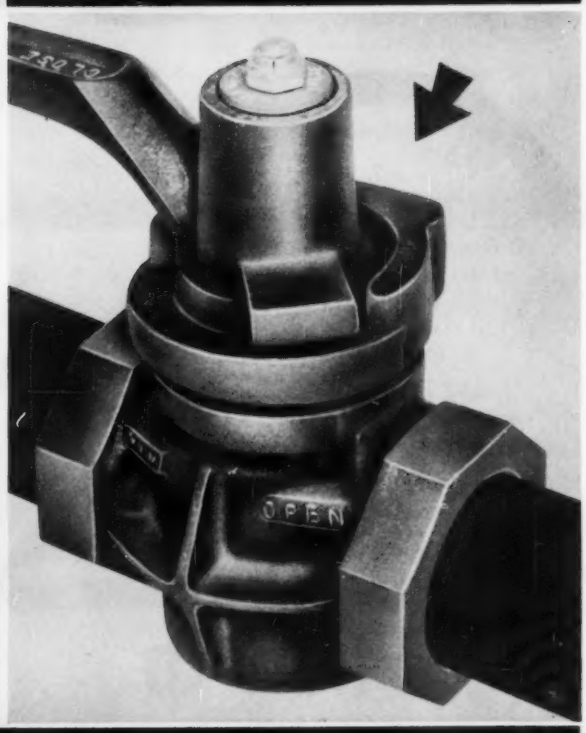

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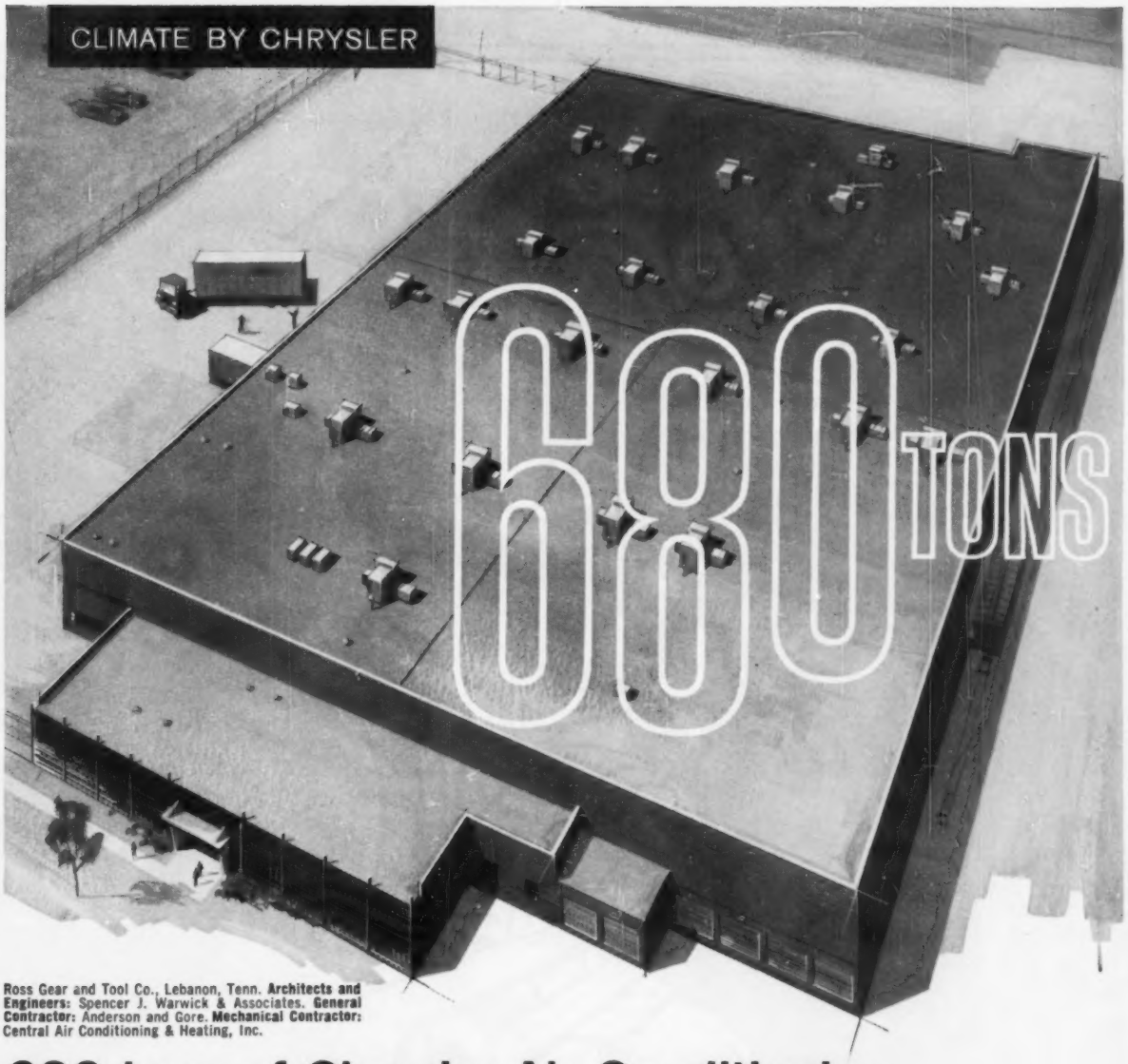

Ross Gear and Tool Co., Lebanon, Tenn. **Architects and Engineers:** Spencer J. Warwick & Associates. **General Contractor:** Anderson and Gore. **Mechanical Contractor:** Central Air Conditioning & Heating, Inc.

680 tons of Chrysler Air Conditioning on the roof save 1100 sq. ft. of valuable floor space inside

Sprouting from the roof of this new plant for Ross Gear and Tool Company are 22 Chrysler 30-ton packaged air conditioning units. Together with two Chrysler packaged liquid chillers and four split-system units, they provide the cooling (785 tons of it!) for almost five acres of manufacturing and office space.

By putting 680 tons of Chrysler Air Conditioning *on* the roof, instead of *under* it, the company freed 1100 sq. ft. of valuable floor space for other jobs. And by installing these units zone-by-zone during construction, the company saved money by starting operations in part of the building while the rest was being completed.

The cooling load is spread over 28 different Chrysler units, ranging from a 4-ton condensing unit to a 45-ton chiller. Thus, varying departmental load requirements can be handled with ease. There is no fixed operating cost, as there would be with a conventional single-unit installation.

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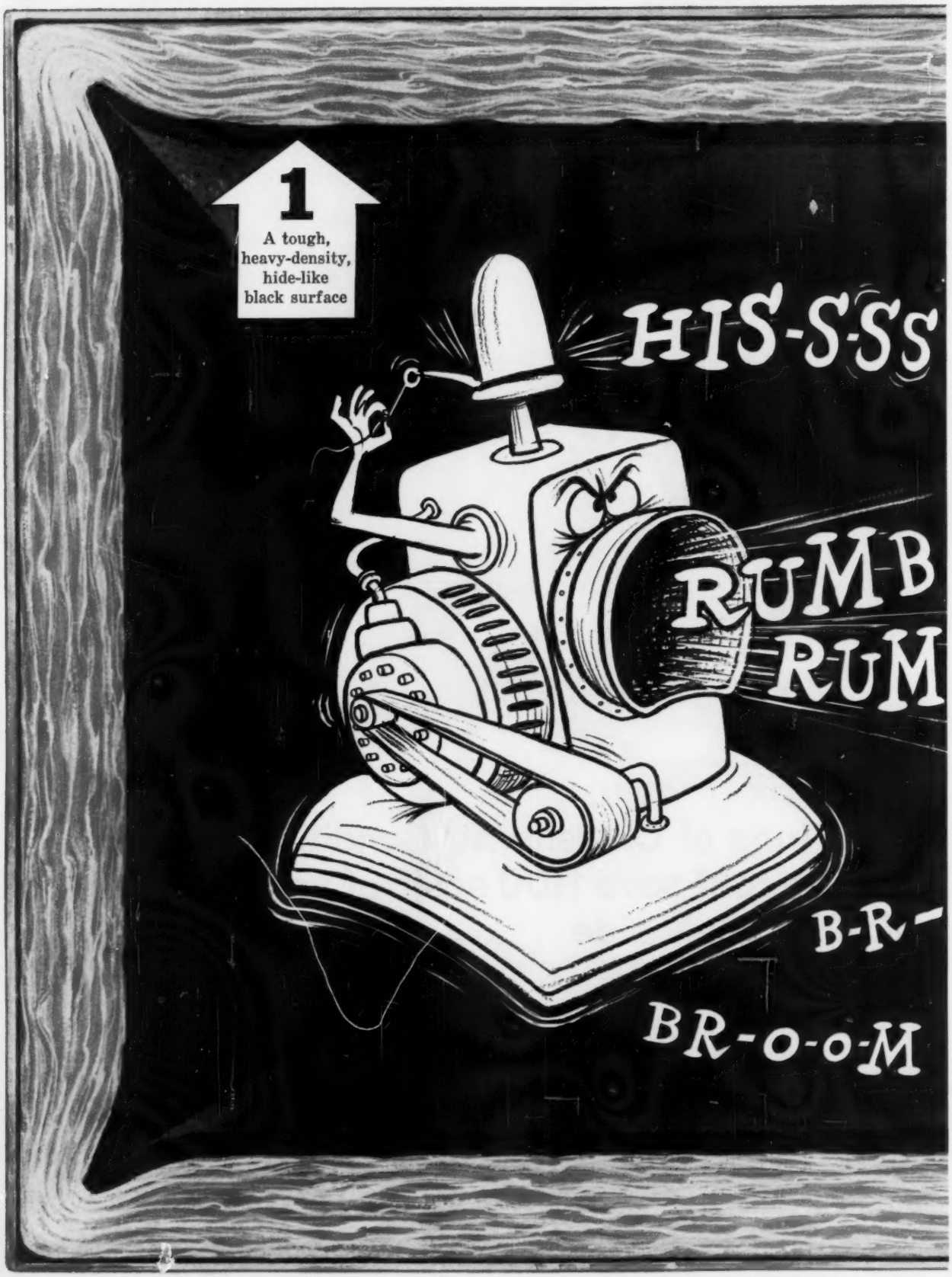
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J-M Micro-Bar is an entirely new concept in sound-absorbent and fire-resistant fiber glass duct liner. Micro-Bar is a combination of *two densities* of insulation, making it highly effective in absorbing duct noises at high frequencies, low frequencies and the range in between.

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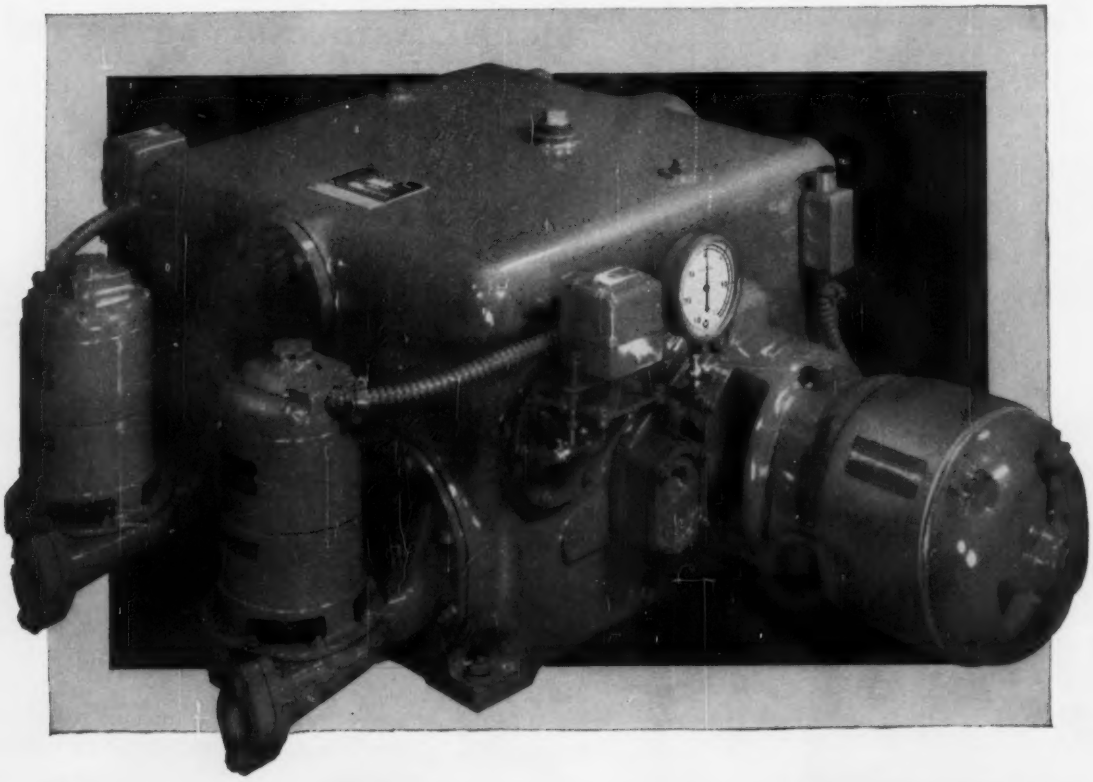

It's the Nash CSM

No longer is it necessary for the Engineer to accept a vacuum heating pump with air and water capacities based inflexibly upon square feet of equivalent direct radiation. With the flexible Nash CSM he can provide for proper air capacity in accordance with his judgment and experience. For the individual capacities of the separate pumps on the CSM may be varied within a wide range, without buying an oversize receiver and oversize water pumps.

These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low, returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

- Increased air capacity induces rapid system response without wasteful overheating.
- Separate air and water pumps individually selected to meet actual job requirements.
- Control system that operates individual pumps only when needed.
- Flexibility permitting addition of radiation without changing basic pump installation.
- Low, low, return line connection.

NASH ENGINEERING COMPANY
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High temperature hot water is a natural choice, says the author, as a primary comfort and process heat source at large campus-type industrial complexes. Its efficient use, however, requires careful attention to design details — helped along by some engineering imagination to match the particular requirements of the job at hand.

Here he comments on some of the problems and solutions related to the design of the HTHW system for the world's largest commercial aircraft maintenance base, in Montreal.

Engineer Explains Problems, Solutions In Using HTHW for Heating and Process Work

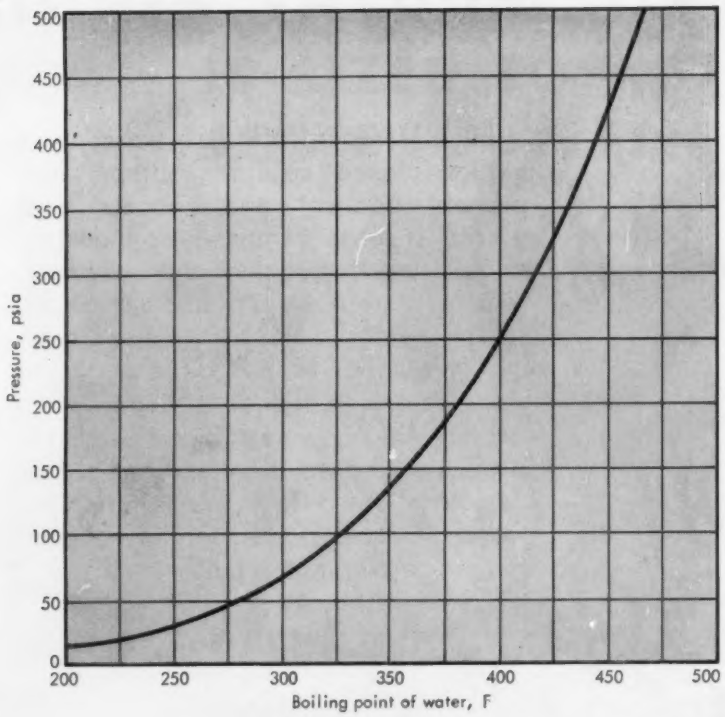
By HARALD L. TAMM
Mechanical Engineer

Mr. Tamm is a graduate of the University of Tallinn and received a Licentiate of Technology from the Royal Technical University in Stockholm. Eight years work as a design engineer in the Scandinavian countries preceded service with two consulting engineering firms in Montreal, where he has lived since 1953.

THE SUITABILITY, simplified maintenance, and economy aspects of high temperature hot water systems for large campus-type industrial complex applications are well known. HTHW was a "natural" for the recently completed Trans Canada Air Lines engineering and maintenance base near Montreal, but the variety of processes and services, as well as the size of the complex and distances to be covered presented some interesting challenges to the design engineers.

Plant Is World's Biggest

This $20 million facility is the world's largest such base and the first designed exclusively for turbine-powered aircraft. Buildings alone cover 14 acres (about 600,000 sq ft), and the combination overhaul-maintenance hanger building (837 by 175 and 487 by 235 ft in the two sections) will handle up to 11 jet or turbo-prop aircraft at one time. Inside are facilities that would permit the 2500 workers employed there to build an entire aircraft from the ground up. Two office buildings and a wide variety of service shops, laboratories, training areas, storage spaces, and the power plant building complete the facility.



1 PRESSURES required by a HTHW system increase very rapidly at temperatures above about 350 F, and if job to be done is primarily comfort heating, economics will dictate selection of a system temperature near or below that value

Nitrogen *vs* Steam Pressurization

One of the questions raised by the use of HTHW is that of nitrogen *vs* steam pressurization. Nitrogen, though it involves the cost of continual replacement, was used for the TCA plant for the following reasons:

1) The operating pressure for the expansion tank could be determined with proper safety margins, eliminating risks of flashing and water hammer at high points in the system.

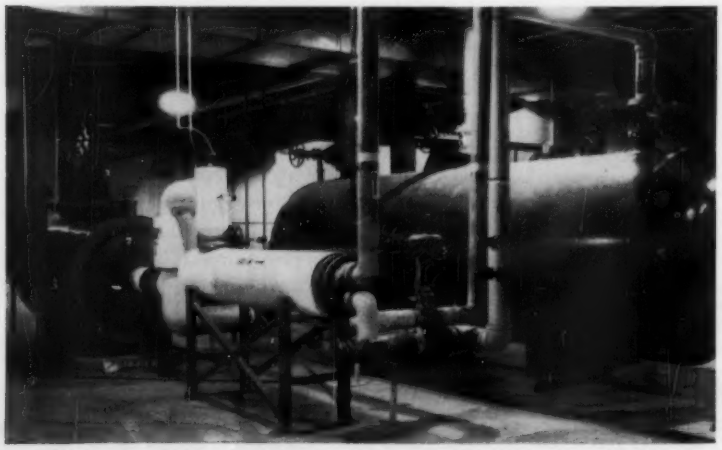
(In steam pressurized systems, flashing is prevented by pressurizing the supply lines or the whole system, either with the main circulating pump or with special system pressurizing pumps. The weak point is that, should pump failure occur, or even at sudden load changes, flashing and water hammer will be permitted at high points in the lines.)

2) During a weekend or holiday shutdown, vacuum would develop at high points of a steam pressurized system, and piping and coils in those areas would be airbound, requiring venting procedures which would introduce oxygen to the system.

(This could have been avoided by maintaining expansion tank steam pressure with a small electrical or direct fired tank heater.)

Setting System Limits

It is always good policy to use no more force than is really necessary to accomplish a task, and this



2 TWO STAGE heating system for compressed air supply includes HTHW heat exchanger in center (to 250 F), second stage electric heater at left (to 450 F), accumulator tank at right

certainly applies to temperature and pressure selections on HTHW systems. The important economic feature of HTHW is a high design temperature differential between the supply and return air lines, resulting in small pipe sizes. This is why HTHW adapts so well to long-distance heating transportation. Reduced circulation capacities also mean smaller circulating pumps and consequently lower overall operating costs.

Very high system temperatures are normally justified only when the job to be done requires high temperatures, or when supply lines are abnormally long. As shown in Fig. 1, necessary system pressures increase very rapidly at temperatures above 350 to 400 F.

Disadvantages of Excessive Temperature

If the major job to be done is heating, a higher heat potential offers no advantage, and in fact usually increases the installation and operating costs because

1) Local heat exchangers with controls and pumps have to be used for office heating, ventilating, and air conditioning systems, adding considerably to equipment costs,

2) Higher system pressures boost the required "pressure class" and cost of all equipment, and

3) Corrosion feedwater treatment will require serious attention at higher pressures.

At TCA, most process heaters could operate at temperatures far below 300 F. HTHW at 320 F is used directly in unit heaters, oil heaters, all ventilation coils, and radiators in shops and corridors. Two office buildings are equipped with perimeter induction systems, using HTHW for heating secondary water. In the corridors (and some auxiliary radiators) of these buildings, HTHW is used directly but is tempered by a local mixing pump to a maximum of 180 F. We call this latter system a high pressure low temperature arrangement.

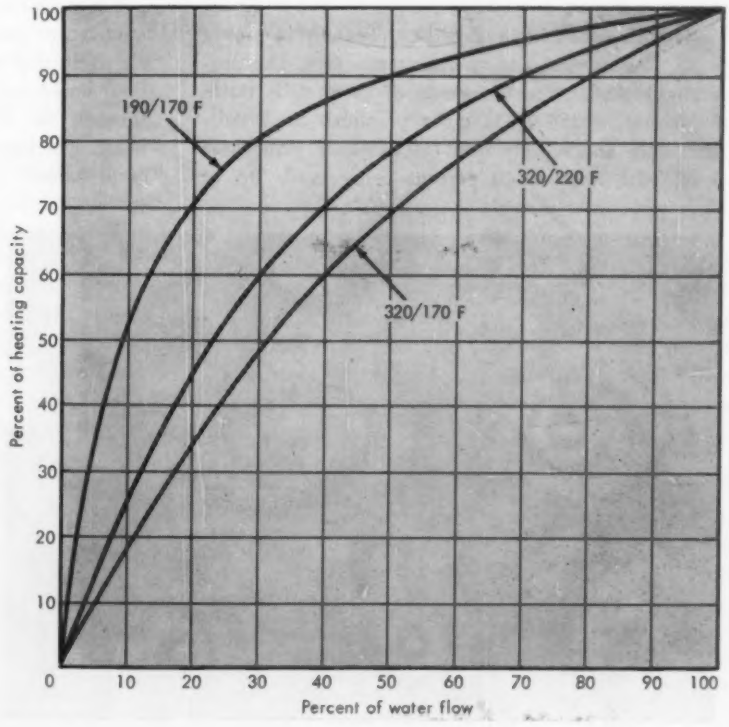
Additional HTHW Use

Two compressed air heating systems, used for aircraft auxiliary turbine testing, have a two-stage heat exchanger supply. Incoming air is first heated by HTHW to 250 F, and then in an electrical heater to a final temperature of 450 F (Fig. 2).

Finally, HTHW is used for two 25 psig steam generator systems to serve kitchen equipment and for cleaning and process tank heaters. Direct use of HTHW for these tank heaters was considered. Steam was preferred because some acid tank heaters were expected to fail at certain time intervals and the resultant flooding of acid tanks with HTHW would present a serious hazard to the operators.

Temperature Differential Is Critical

A high temperature differential between supply and return water lines is important for economy, but



3 DIFFERENTIAL between supply and return water temperatures has important effect on criticality of design. Where differential is 100 F (320/220), a 50 percent reduction in supply water volume to a unit will decrease heating capacity by an amount more than double the decrease that would occur with a 20 F differential (190/170)

the greatcr this difference the more carefully the system must be designed and balanced. As shown in Fig. 3, a 50 percent reduction in supply water volume to a 190/170 F radiator will cause only a 10 percent decrease in heat output, but a similar short-changing on a 320/220 unit will more than double that loss.

Several factors limit the practical temperature differentials to a range of 100 to 200 F for any system which includes a large number of direct-connected heaters. In the first place, theoretical hydraulic calculations are somewhat limited; then it is impractical to throttle and balance supply flow at the small volumes related to higher temperature differentials; and finally heater costs go up as temperature differential increases.

The following are the design temperature differentials (Δt) for the TCA installation:

150 F — for all heating coils in air conditioning and ventilation systems.

100 F — for direct-connected heaters (unit heaters, hangar heating coils, radiators, converters, etc.)

50 F — for steam generators, ovens and process heaters where higher operating temperatures necessitated higher return water temperatures.

How Differentials Were Set

Higher temperature differentials for ventilating and heating coils were selected to facilitate the operation of automatic controls (see Fig. 3) and also because of economic considerations. A 150 F Δt for these coils appeared to allow best economy in piping costs, heater costs, and operating expenses. The generally high heat requirements of these coils made balancing at 150 F Δt quite practical. Such coils constitute about 40 percent of the total plant heat load, with another 40 percent being made up in year 'round units — process heaters, water heaters, air conditioning reheat coils, etc.

Use 3-Pipe Heating Return

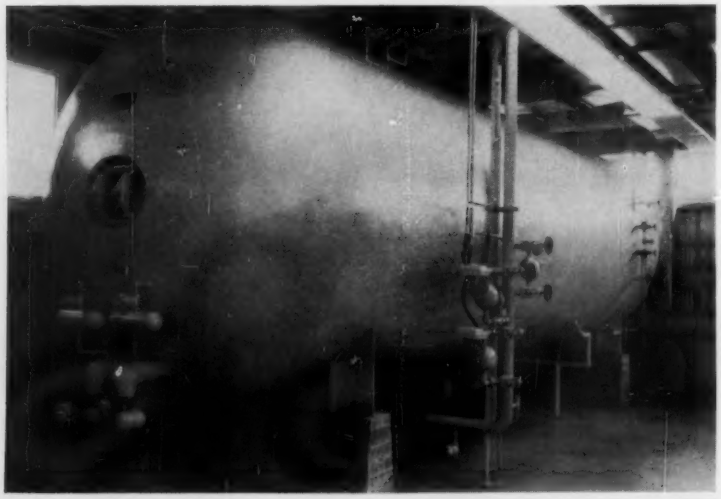
The HTHW return is a kind of three-pipe arrangement. A 12 in. main supply header is branched (at the entrance from the boiler house to the pipe tunnel) into a 10 in. winter supply main and an 8 in. all-year supply main. The larger pipe feeds all heaters which operate during the cold season only, and the smaller the process, reheat, and other coils that are supplied year 'round.

All return lines are joined in a common return system which terminates in a 12 in. main leading back to the boiler house. Three main circulating pumps, each with a capacity equal to 50 percent of the total, are used. Two operate in parallel during the heating season, while during the summer only one is needed.

What Return System Provides

The return arrangement gives both economy and ease of operation. When heating is not required, the operator can deactivate the entire winter distribution circuit simply by closing one valve in the boiler house and stopping one pump. Because some areas (paint shop, process shop, etc.) require a high air change rate, it is often necessary to operate the winter system for a few early morning hours "between seasons." This frequent switchover is easily accomplished with the separate winter/summer arrangement.

Check valves are installed at all winter system-common return junctions to avoid parallel water flow after shutting down the space heating lines. Otherwise flow could be reversed from the common return through the winter system lines, through another heater and into the common return at a point of lower pressure.



4 EXPANSION tank has small heating coil, plus trap in expansion line to keep water temperature up, prevent excessive dissolution of nitrogen and "double flow" in expansion pipe

Three Boilers Furnish HTHW

The boiler plant includes two 45 million and one 25 million Btu per hr units, each equipped with two wide range mechanical atomizing oil burners and automatic combustion controls.

Oil is circulated by a two-stage pumping set with oil heaters installed between the first and second pumps. This maintains the heater oil pressure at a value lower than the HTHW pressure to avoid possible oil leaks to the HTHW system.

Selecting the Pressure Range

The choice of a proper operating pressure range is of extreme importance for any nitrogen pressurized system. A narrow range between the expansion tank relief valve setting and that of the makeup gas valve would raise nitrogen replacement costs greatly unless a complicated nitrogen relief and recovery system or waterside relief and re-pumping system were used. A moderate system pressure, however, allows a simple expansion tank setup with a minimum of nitrogen gas loss.

The maximum system water volume variation (ΔV) which occurs because of temperature variations can be easily calculated. The necessary pressure range (ΔP) between the makeup and relief valve settings which will eliminate valve openings at temperature extremes can then be calculated from

$$P/(P + \Delta P) = (V - \Delta V)/V$$

where

V = expansion tank volume at minimum water level

ΔV = maximum expected system water expansion

P = minimum allowable operating pressure

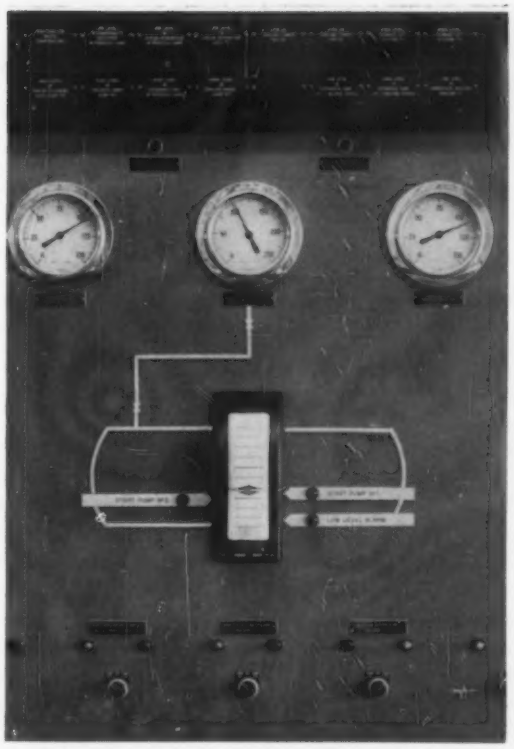
$P + \Delta P$ = relief valve setting

It is obvious that at a certain expansion tank size, V, and a certain practical pressure setting range ΔP, the expansion size ΔV which can be absorbed is a function of the selected system pressure P.

Minimum expansion tank operating pressure for the TCA plant was set at 110 psig, which value at 320 F water temperature includes a safety margin of 25 psi against flashing in high points of the system with pumps inoperative. With pumps operating, the system pressure will be higher and the safety margin consequently increased. It is therefore possible to operate the plant at slightly higher temperatures occasionally for quick heat-up or other reasons.

The maximum expansion tank pressure was set at 140 psig, giving a $P/(P + \Delta P)$ ratio of approximately 0.8.

Necessary expansion tank capacity was now established at 8800 gal, and an 8 ft diameter, 22 ft tank was chosen. Fig. 4 shows the arrangement of auxiliaries on the expansion tank. A ½ in. solenoid valve



5 MAKEUP TANK instrument panel includes remote expansion tank level indicator plus makeup pump operating lights

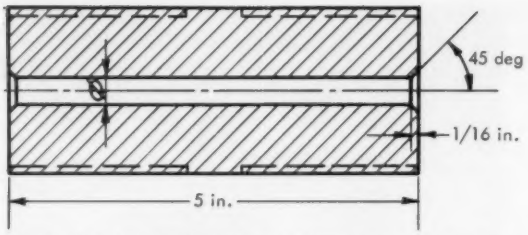
in the nitrogen supply line is controlled by a pressurestat, and will be opened whenever pressure drops to 110 psig. A ¾ in. solenoid relief valve is set to open when tank pressure rises to 140 psig. Two additional spring-operated 3 in. safety valves, set at 143 and 146 psig respectively, are also installed on the tank. Rupture discs are included to eliminate leakage through two large safety valves.

To Restrict "Solubility" Losses . . .

Solubility of gases in water is a factor which should be carefully considered for nitrogen pressurized systems. Water in the expansion tank will be saturated with nitrogen, but the amount of nitrogen dissolved will depend on system pressure and tank water temperature. Highest solubility will occur at high system pressures combined with low water temperature. This not only increases costs (nitrogen loss) but nitrogen in solution which is circulated through the system will separate and collect at piping high points, requiring frequent venting of air bottles with possible interruption of water circulation to some heaters.

. . . Keep Temperature Up

At TCA, the expansion tank is equipped with a



6 SCREWED ORIFICE plates (above) are used on lines smaller than 3 in., flanged orifice plates on lines 3 in. and larger, wherever excess pressure must be throttled. Minimum orifice opening is ⅛ in. Orifice plate calculations included compensation not only for shock loss but for combination of shock loss and friction loss

small heating coil and a trap in the expansion line. This keeps tank water temperature up. Without the heater, tank water would cool and more nitrogen would go into solution. The temperature difference between tank water and water in the system mains below (different specific gravities) would cause a double circulation in the expansion pipe — with cooler water flowing downward along the pipe walls and warmer water flow up through the center. Heat loss through the pipe walls and the laminar flow characteristic would further stimulate such gravity flow in the pipe.

The small heating coil (and tank insulation) makes it possible to maintain tank water temperature practically equal to boiler outlet temperature. The trap in the expansion line efficiently stops gravity circulation in the expansion pipe caused by the heat loss through the pipe walls.

Total Nitrogen Loss: 20c Per Day

Nitrogen losses at TCA have been about one bottle in 2 to 3 weeks, caused mostly by leakage through water gage gaskets and other connections. At a price of $3 per bottle, the daily nitrogen cost is only 20 cents.

Avoid Water Waste

Some HTHW installations require what must be considered as grossly oversized makeup pumps — due simply to excessive water waste. Every effort should be made to avoid loss of system water. Manually operated air bottles rather than automatic vents should be used, together with welded rather than screwed or flanged valves, and circulating pumps which will require no loss of system water for bearing cooling. Good water conservation will either eliminate or greatly reduce water treatment requirements and help avoid corrosion.

Two reciprocating makeup water pumps are used for TCA, No. 1 having a capacity of 4 gpm and No. 2, 12 gpm. No. 1 is started at a set low level in the expansion tank, and a further drop will automatically start the second pump and sound an alarm on a central annunciator panel. If the water level reaches the bottom of the expansion tank, boilers are automatically shut down. A switch in the makeup tank will stop both pumps and sound an alarm if low level occurs in the makeup tank.

Makeup requirements for this plant, according to the actual log sheets, have been about 10 to 15 gal per week, causing makeup pump No. 1 to operate once every two weeks. Fig. 5 shows a section of the control panel with remote expansion tank level gage, and makeup pump indicating lights.

The three circulating pumps for the HTHW are equipped with a heat exchanger cooling system for bearings. This arrangement overcomes the weakness of many directly cooled pumps, where considerable quantities of system water are continuously lost

7 HOT PIPING lines supported from roof or trusses include tied universal and pressure balanced stainless steel expansion joints to reduce reaction forces on anchors

through leakage to the cooling system. All pumps are equipped with mechanical seals.

How Flow Is Controlled

Heaters and heat exchangers with HTHW connections larger than 1 in. are equipped with three-way control valves. A relatively constant circulation rate through all parts of the system eliminates sudden pressure fluctuations in branch lines at starting, stopping, or changing rate of flow. A pressure fluctuation at one heater would change the flow through all others connected to the same branch and require a readjusting action from all other controls. The three-way valve arrangement also guarantees that heat is available at each exchanger instantly at all times, since water is not allowed to cool off in "dead" branches. Finally, this plan eliminates the risk of low circulation through the boilers during low demand periods.

Use Fixed Orifice Plates

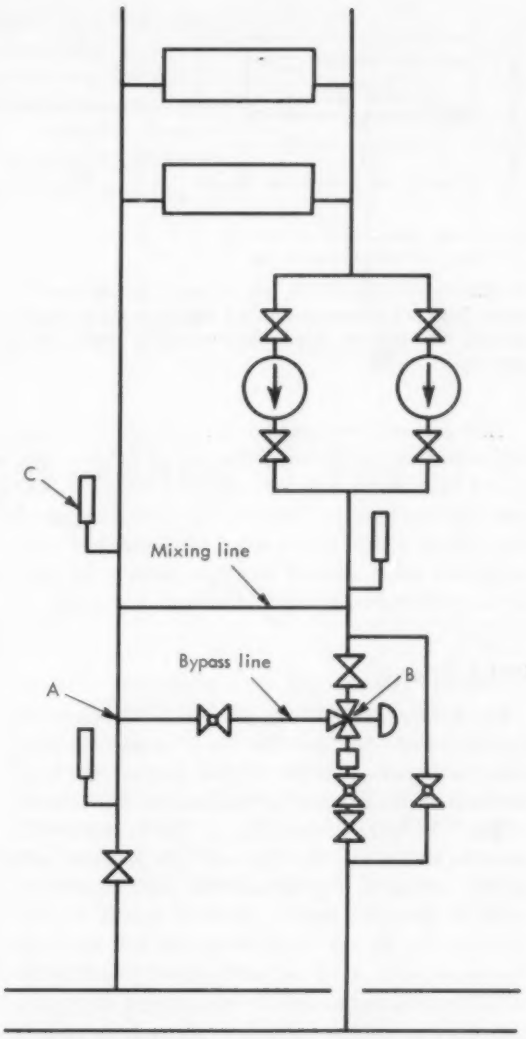
The entire system was carefully balanced hydraulically by using proper pipe sizes and orifice plates wherever excess pressure had to be throttled. Ordinary flanged orifice plates were used for pipes 3 in. and larger, with screwed plates (Fig. 6) for smaller sizes. The latter, of course, represented the great majority of heater connections. The minimum orifice opening used is $\frac{1}{8}$ in. Plates had to be calculated not only for shock loss but for a combination of shock loss and friction loss.

Balancing the system in this way requires a thorough knowledge and experience in hydraulic calculations, but this is always the most satisfactory way. Throttled or half-open valves on a unit will always be opened by an operator whenever complaints about the performance of a unit are heard. This can easily upset the system balance.

Keep Circulation Rate Constant

Orifices were also used in the three-way bypass lines except in cases where the pressure drop through the heater is very small. Making the bypass line resistance approximately equal to the resistance through the heater gives a most satisfactory control characteristic and maintains a relatively constant total circulation rate.

Low pressure process steam generators (with balancing orifices) have automatic two-way bypass valves installed which open at low pressures. This provides a considerably higher HTHW circulation rate through the generator than the normal rate used for hydraulic calculations, but provides for quick heat-up on Monday mornings without penalizing the system continually with higher circulation requirements. Temporarily upsetting circulation balance in this manner has introduced no practical disadvantage.

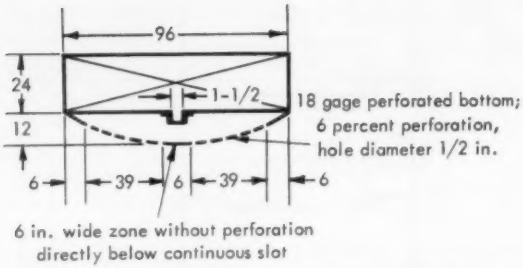


8 HPLT SYSTEM for corridor radiators is tied into HTHW system as shown here. With supply in left line, main pressure occurs only to Point A, with local pump supplying remainder. Valve B is wide open to HPLT system at full load

Only one main strainer is installed in the 12 in. return line to trap solids and impurities which may have remained in the system after the original filling.

Piping Installation Methods

All HTHW piping and most of the valves were made with welded connections. Socket welding fittings were used for pipe sizes 2-$\frac{1}{2}$ in. and smaller to avoid unpleasant surprises in the form of throttled flow areas at small-pipe junctions. About 10 percent of the welded joints were inspected by gamma ray radiography before insulation was applied.



9 PERFORATED DUCTS, 200 ft long, and designed as shown here (all dimensions in in.) distribute air to engine cleaning and process shop, where corrosive fumes are a problem

Tied universal and pressure balanced stainless steel expansion joints were used for all hot piping supported from the roof trusses and joists (Fig. 7). The resulting small reaction forces on anchors (compared with forces which would have developed had pipe loops been used) allowed very light joists to be used, for a considerable saving in structural steel costs.

HPLT System

Fig. 8 shows how the high pressure low temperature system, used for corridor and some auxiliary units, is connected to the HTHW system. The high temperature main water is tempered to a maximum of 180 F by local mixing pumps. This system is balanced in such a way that the available pressure from HTHW covers, in Fig. 8, only the pressure drop to point *A*. Pressure drop in the local system is compensated for by the local pump. At full load, the three-way valve at *B* is fully opened towards the HPLT system, and no flow occurs through the bypass line, whereas enough water flows through the mixing line to maintain a 180 F temperature in the supply line at *C*.

Panel Controls Complete System

A remote control center in the boiler house provides operational control and adjustment of the approximately 130 heating, air conditioning, ventilation, process, and dust exhaust systems housed in 13 penthouses among the different buildings. Colored functional layouts which indicate the location of dampers, heating and cooling coils, fan motors and controlling devices can be brought into view on a graphic presentation panel as desired. Each control device is indexed in a manner that allows indication and recording of important data on nearby instruments. Cooling equipment data for the office building system is available from a separate panel adjacent to the heating console. Fifty filter media run-out annunciator lights for the roller type disposable filters are grouped on the lower part of the cooling panel. The control console also includes some 86 control point adjusters, cross-indexed to agree with points shown on the display screen.

Air Distribution

As noted earlier, the two office buildings at the TCA site have perimeter induction system air conditioning, using HTHW for heating secondary water.

Hanger areas are heated by floor trench air curtain systems along the hanger doors, plus a small number of high level supplementary unit heaters, included primarily to transfer hot stratified air from upper levels down to working zones, thus reducing temperature gradients in vertical planes. The air curtains in the hangars are supplied from 12 fan and coil stations using axial flow fans of a total capacity of 450,000 cfm.

Special caution was exercised in the design of the ventilation system for the engine cleaning and process shop because of the considerable hazard to the entire plant from highly corrosive process tank fumes.

A two-speed air supply unit (50,000/25,000 cfm) plus a single speed unit (50,000 cfm) are installed for this shop. Both are equipped with inlet vane dampers controlled by a room pressurestat to maintain a negative pressure in this area. Supply air is distributed to the room via two 200 ft long by 8 ft wide perforated ducts having internal balancing plates (Fig. 9) and curved bottoms.

Three-Part Shop Exhaust

Contaminated air is exhausted from this area by 1) a tank exhaust system, 2) exhaust fans for a number of cleaning spray booths, and 3) two dust exhaust systems. The largest exhaust volume is handled by the first (tank) system. A 12 by 4 ft PVC exhaust duct is brought from an acid-proof exhaust plenum in the basement to two PVC-lined centrifugal fans. The 5 ft sections of this 30 ft high vertical duct, which leads to a penthouse on the roof, are equipped with plasticized PVC gaskets to absorb thermal expansion of the duct.

One of the two main supply units and one tank exhaust fan are connected to the emergency power system, thus allowing uninterrupted ventilation of the shop in the event of main power failure.

Architects, Engineers

Architect for the TCA plant was E. Sellors, TCA Chief Architect, and Ross, Fish, Duschenes & Barret. J. B. Keith & Associates served as mechanical consulting engineers. The valuable assistance and cooperation of TCA architects and engineers is gratefuly acknowledged. ╪

It doesn't always pay to insulate pipe flanges, but the author of this article insists that it does pay to consider insulating them. Herein he presents his case, explaining the various factors which control the economic advisability of insulating pipe flanges.

Mr. Gross holds a mechanical engineering degree from the University of London, and has had experience in England, Canada, and the U.S.

Insulating Pipe Flanges — Does It Pay?

By WILLIAM L. GROSS
Senior Mechanical Engineer
Colgate-Palmolive Co.

NO ENGINEER would install a pipe carrying steam—or any other hot gas or liquid for heating purposes—without providing adequate insulation. And most engineers will routinely call for valves and other fittings to be insulated. But too often these same engineers fail to consider insulating the pipe flanges.

Economics, Safety, and Operating Problems

If we examine the question of flange insulation we find that it is foremost an economic problem, next a safety problem, and thirdly an operating problem. In this article the economic aspect will be used as the basis for discussion, since this is the consideration which is frequently overlooked. Existing plant procedures and standards usually take care of the other two points.

It does not always pay to insulate flanges, but it does pay to consider insulating them. The decision ultimately depends on how long the installation will be in use, on possible danger by leaving flanges uninsulated, and on whether the heat given out by uninsulated flanges contributes unduly to raising the ambient temperature.

Selecting Thickness of Insulation

When selecting flange insulation, thickness of the insulating material is chosen on the basis of the material's conductivity, the pipe diameter, temperature of the fluid, ambient temperature, and the type of use (commercial, industrial, power, process, etc.). For the purpose of this investigation, a thickness for each example was selected to result in an outside canvas temperature of 100 to 115 F. Except with small pipe flanges, it is possible to control outside temperatures with a high degree of accuracy.

In addition to the canvas temperature, the following assumptions were made:

Ambient temperature, 75 F
Thermal conductivity of lagging
at 175 F, $K = 0.375$
at 250 F, $K = 0.400$
Cost of steam production, 60 cents per 1000 lb.
Hourly cost of insulation installer, $6.60
Pipe temperature and flange temperature are assumed equal to steam temperature.
Cost of insulation was taken from the standard price list of manufacturers without allowing for discounts. Prices are for fibrous molded asbestos insulation.

How To Determine Heat Loss

Heat conduction through the insulation, and convection plus radiation to atmosphere, were calculated from the following formulae for horizontal pipes published by the Mellon Institute:

Conduction

$$h = K\ (T_1 - T_2)/[r_1\ log_e\ (r_2/r_1)]$$

Convection and radiation

$$h = 564\ T_d/D^{0.39}\ (272.5 - T_a)$$

where

h = Btu per hr per sq ft of outer canvas surface
T_d = temperature difference between outer surface and room, F

Insulating Pipe Flanges — Does It Pay?

D = outer canvas diameter, in.
K = insulation conductivity, Btu per hr per sq ft per F
T_1 = temperature of inner surface (equals steam temperature), F
T_2 = temperature of outer canvas surface, F
r_1 = radius of inner surface, in.
r_2 = radius of outer canvas surface, in.

The heat loss from bare or insulated flanges was used as being equal to that of a section of bare or insulated pipe of equivalent surface area. Heat loss from bare pipes was also obtained from tables published by the Mellon Institute. On the graphs, Figs. 1 and 2, heat loss has been converted to fuel costs, expressed in dollars. The examples given are for 24-hr-a-day, seven-days-a-week operation.

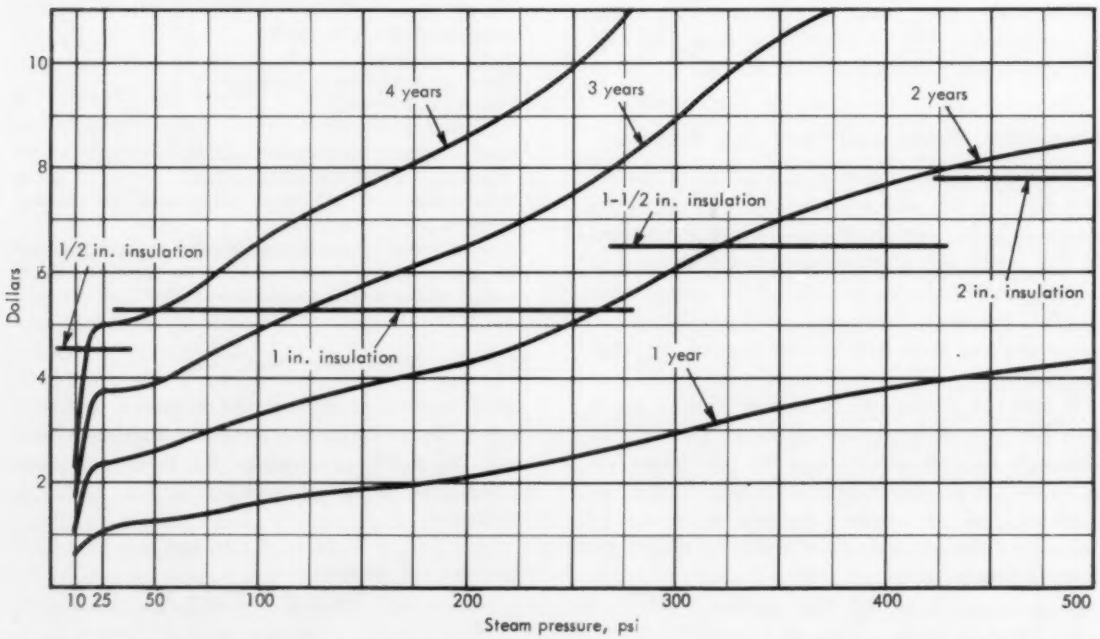
Results of the above calculations are shown in these graphs for 1-½ in. pipe flanges with temperatures equivalent to saturated steam at up to 500 psi, and for 10 in. pipe flanges with calculations carried up to temperatures corresponding to saturated steam at 200 psi. Discontinuities in flange insulation costs are due to an increase in insulation thickness to keep outside temperatures within stated limits; the appropriate insulation thickness is marked on the graphs.

Selection of thickness within these discontinuities is largely a matter of personal choice. The graphs show a family of fuel cost curves covering time spans of from one to four years and from one half to one year.

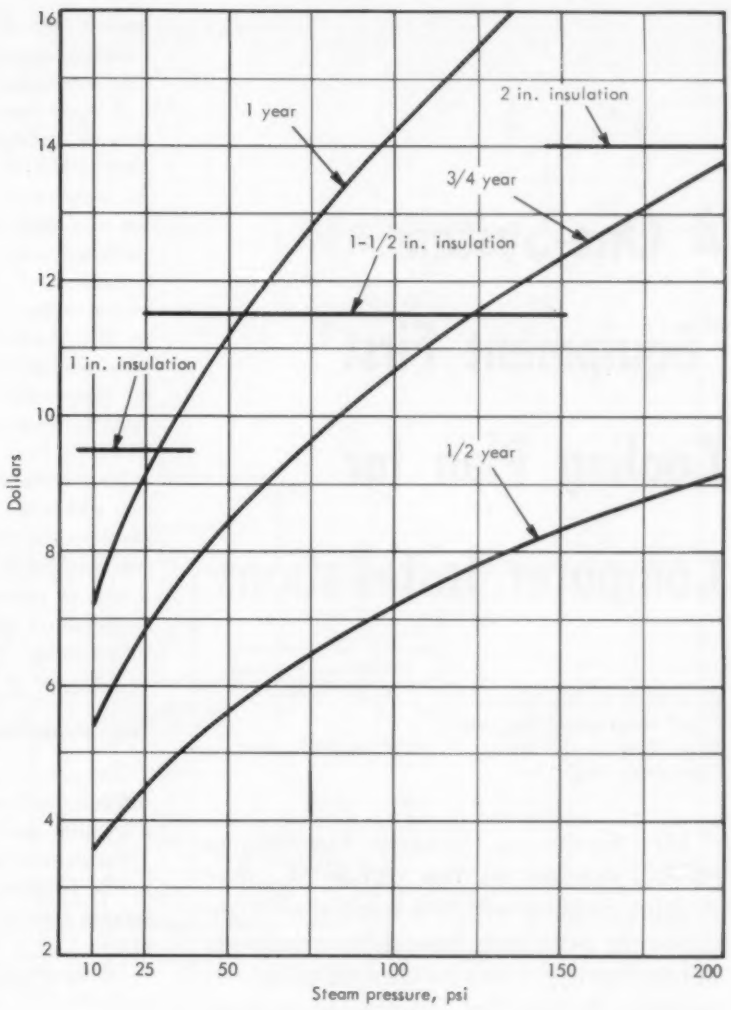
When To Insulate Pipe Flanges

When is it worth while to insulate flanges? In one case (Fig. 1) it can be seen that with a 1-½ in. pipe flange it would take over two years to make flange insulation pay even at temperatures corresponding to a steam pressure of 200 psi. At the other extreme (Fig. 2) we have a 10 in. pipe flange where insulation pays even with 50 psi steam after one year. This points out the fact that each case must be decided individually. Clearly, the break-even point is where the fuel cost curve crosses the flange insulation cost line.

Let's look at a specific example of a steam pipe installation with an expected useful life of five years. The installation includes a system of pipe flanges as outlined in Table 1. In striking a cost balance, yearly maintenance costs have been ignored, as this item with a good initial installation is very low. What has to be taken into account though is the "cost" of money, since any sum, if it were not spent, could be invested at about 4 percent annual return.



1 WITH VERY SMALL pipe flanges at low steam pressures, it is not economical to insulate the flanges. These curves are all based on a 1-½ in. pipe flange. Heat loss at various temperature conditions corresponding to steam pressures is shown as fuel costs for periods indicated. It takes over two years at system temperatures corresponding to a steam pressure of 200 psi for flange insulation to pay for itself when used on 1-½ in. pipe flanges



2 LARGE PIPE FLANGES with resulting high heat loss surface area make it possible for pipe flange insulation to pay for itself in relatively short periods. For example, insulating a 10 in. pipe flange with 1-½ in. insulation on a system with temperatures corresponding to a steam pressure of 50 psi saves enough to pay for itself in only a year. These curves are all based on a 10 in. pipe flange. Heat loss at various temperature conditions corresponding to steam pressures is shown as fuel costs for periods indicated

The graphs have been worked out for a definite set of conditions. With variations in labor rate, insulation costs, steam generation, etc., it may be either more or less advantageous to insulate flanges than is shown here. The graphs are presented only as a guide; each system should be considered separately.

Finally, let us look at a matter of engineering practice. Many engineers are hesitant to insulate flanges for fear that leaks may go undetected and thus corrode flanges and bolting. The easiest solution to this is to insert a ¼ in. pipe at the joint face, pointing downwards, acting as a tell-tale. Actually, insulating pipe flanges reduces the likelihood of flange leakage as insulation reduces temperature stresses. ⫩

TABLE 1 — Data presents the various cost factors of insulating a hypothetical piping system with an expecte 'e of five years that uses pipe flange insulation

Qty.	Flange size	Insulation cost	5 years at 4 percent interest per annum	Total insulation cost	Fuel cost
100	1-½ in. at 50 psi	$ 530.00	$ 114.40	$ 644.40	$ 630.00
50	2-½ in. at 100 psi	312.50	67.40	379.90	662.50
50	2-½ in. at 50 psi	312.50	67.40	379.90	507.50
10	4 in. at 25 psi	75.00	16.20	91.20	146.00
				$1495.40	$1946.00

A One-System, "Equipment First" Cooling Plan for Computer Installations

By PHILIP A. GREEN
Chief Mechanical Engineer
Pope, Evans and Robbins
Consulting Engineers

Mr. Green is already familiar to HPAC readers as the author of other articles dealing with the special air conditioning problems posed by advances in technology. Here he describes a one-system design for computer spaces which handles both equipment and comfort cooling with a unique "constant pressure" device.

PAST EXPERIENCE with designs of air conditioning systems for large computer installations has shown the need for careful coordination between air conditioning engineers and the computer manufacturers. This article describes a missile guidance computer project for which the designs of the electronic cabinets and the cooling system were handled concurrently, with close coordination between the designers. This relationship proved very fortunate. It was possible to introduce a new concept in air distribution which proved most successful.

How Temperature Limits Were Set

Cooling requirements for the electronic components were determined through consultation with the equipment maker. It was apparent that air cooling was needed both for the components and for the surrounding environment, and that there would be specific acceptable limits.

A curve was plotted relating the life of the transistors to ambient air temperature. At temperatures above 100 F, the life of a transistor is relatively short. As temperature decreases, transistor life increases, but at a diminishing rate, and becomes asymptotic to the temperature axis at about 70 to 75 F.

Analysis of this data, plus the knowledge that interior cabinet air temperature would be increased by heat dissipation of the components, moved us to set a preliminary limit of 60 to 65 F for the supply air temperature. In addition, the temperature variation between components within a cabinet was limited to 10 F.

Since some stratification and unequal air distribution within the cabinet were to be expected, the temperature rise of the air flowing through the cabinet was established at an average of 9 F. This allowed a plus or minus 10 percent variation in component temperatures due to unequal velocities and variations in the ratios of exposed surface to heat emission.

Next Problem: Relative Humidity

The selection of a relative humidity limit was more difficult. Sufficient data was not available on which a scientific decision could be based.

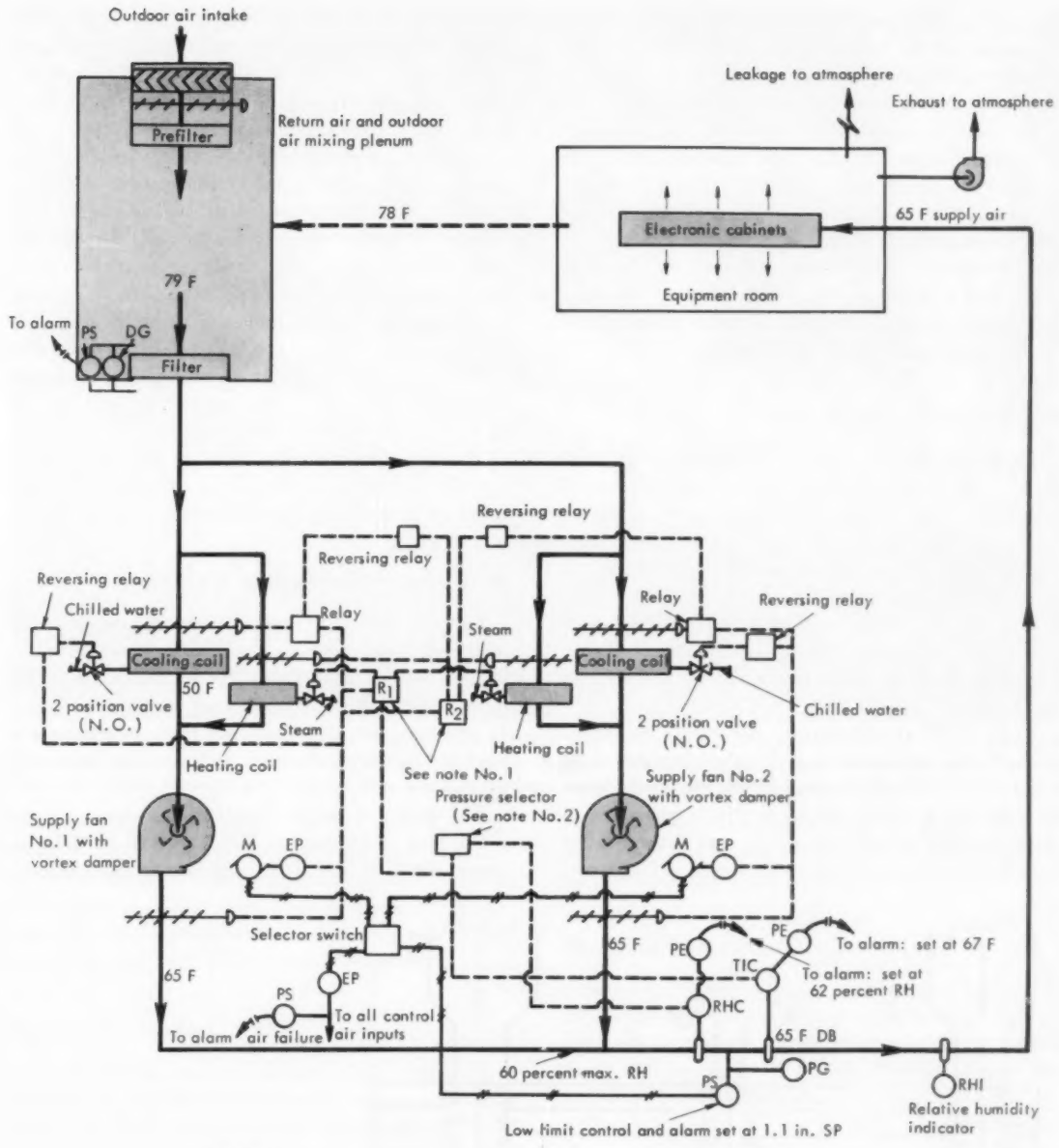
On the one hand, a high relative humidity would not be desirable, encouraging as it would electrostatic leakage between components, with resulting computer errors.

On the other hand, the arbitrary selection of an excessively low relative humidity for the supply air would result in low dew point temperatures, low room RH's, and undoubtedly a more complicated and costly refrigeration system.

These difficulties were resolved by accepting as an upper limit the highest RH that could be maintained without detrimental effects to the various computer components. Discussions indicated that this value should not exceed 60 percent. Not only would this plan allow simplification of the design, but it would also serve to prevent static discharges within the room. This is important because a low RH, for instance 30 percent, in the room air encourages static discharges from operating personnel, and this in turn will result in computer errors.

Providing Proper Room Conditions

During normal operational periods, the computers run continuously at 100 percent power output, resulting in a constant heat output. Lighting load could also be considered as a constant gain throughout the year, since in this case the building was windowless.



LEGEND

M	Motor	TIC	Temperature indicator controller
DG	Draft gauge	RHC	Relative humidity controller
PE	Pneumatic electric relay	R	Relay
EP	Electric pneumatic relay	------	Pneumatic lines
PS	Pressure switch	—//—	Electric lines

NOTES

1. R1 and R2 shifts control from fan No.1 to fan No.2 as fan motor No.1 shifts to fan motor No. 2 depending upon position of unit selector switch.
2. Pressure selector permits humidity controller to overide temperature control when relative humidity rises above 60 percent (51 F dewpoint) pressure selector selects lower pressure.

1 CONTROL SYSTEM for computer space air conditioning project was designed to insure tolerable equipment temperatures, humidity first while at the same time providing adequate comfort cooling for surrounding spaces. Duplication of equipment prevents shutdown due to mechanical failure. At highest supply air temperature of 65 F, air exhausted to room is at 78 F. Note bypasses around cooling coils, which at less than design loads permit greater percentage of outside air to enter without cooling, except when outside RH exceeds 60 percent

The sum of these two loads represents approximately 95 percent of the total design sensible heat gain for the air conditioning system. It was to be expected, then, that cooling would be needed year 'round.

The receiver building which houses the largest of the computer systems contains approximately 400 cabinets. These are subdivided into racks for various electronic components, and the electrical load for each rack varies with its function. Consequently, the air requirement for each rack is different. Finally, provision had to be made for maintenance of the cabinets, which involved removal of front panels, without upsetting the air distribution system.

One System Does Both Jobs

To achieve the dual objectives of equipment and room cooling, an open-type system was selected. In this design, conditioned air is ducted to the computer while warm air discharged from the computer is released to the room. Return air is drawn from the room area. A schematic of the system is shown in Fig. 1. The big advantage with this kind of design, of course, is that both cabinets and room areas are maintained within design conditions by a single air conditioning system.

At 65 F DB and 60 percent RH supply air conditions, the air environment within the computer room will be 78 F DB and 40 percent RH during the summer. As noted above, the room RH is important in the prevention of static discharge, and if the relative humidity of the supply air were reduced to 50 percent or less, RH in the room would be 30 percent or less during cold weather — an unacceptable condition.

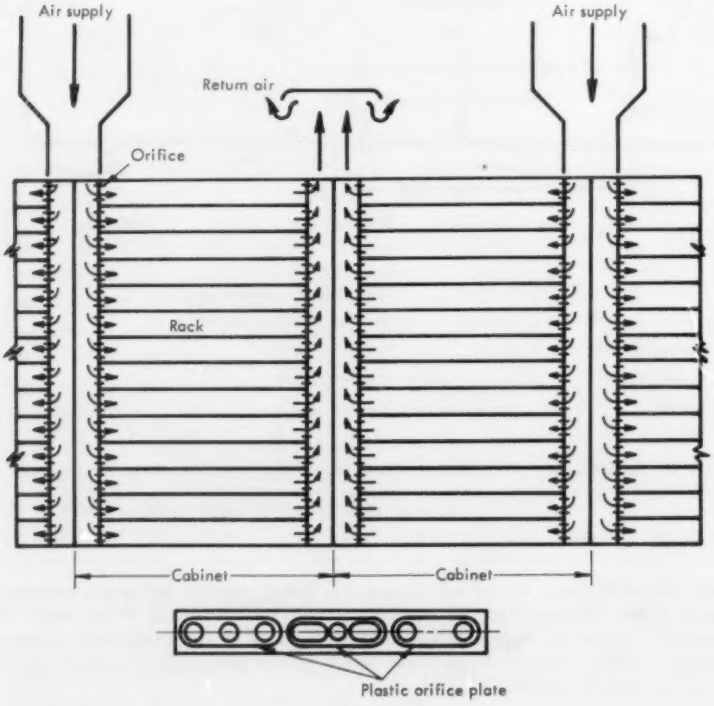
This type of air distribution system can be so designed that it will not be affected during maintenance operations even though individual covers and racks may be removed. This is made possible by the use of orifice plates at the entrance to each rack.

These orifice plates are constructed of plastic with a series of holes drilled through them. They are inserted in the wall dividing the supply air plenum from the individual computer racks (Fig. 2). The plastic inserts are designed to impose a pressure drop of 1 in. WG for a specific air volume, which is calculated on the basis of the amount of air needed to dissipate the heat from each rack according to the electrical load and an assumed 9 F temperature rise. The orifice plates are color coded according to their air volume per specified drop in pressure — each insert being intended to serve for a specific range of loads.

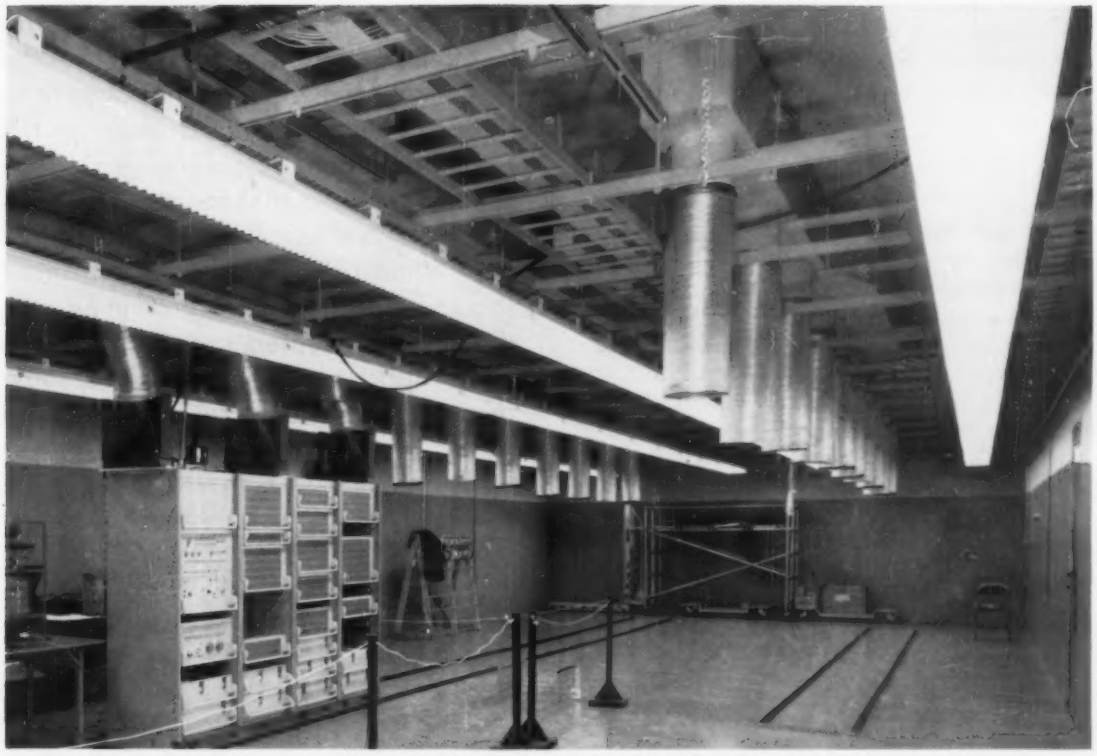
Why The Orifice System Works

Since the orifice represents about 90 percent of the total duct and cabinet resistance to air flow, the effect of opening the cabinet door for servicing has a negligible effect upon the leakage of air into the room. In addition, the high resistance tends to eliminate a need for balancing dampers and extensive balancing procedures.

The design of the air distribution system provides for a drop in pressure of less than 0.08 in. WG between the first and last branches to the cabinets.



2 CABINET SUPPLY to individual racks is via orifice plates (see enlargement) which represent 90 percent of total air resistance. This allows cabinet doors to be removed without affecting system balance. Orifice plates are designed for specific ranges of loads, are matched to electrical loads of each rack — therefore to amount of heat that must be dissipated



EQUIPMENT RACKS for computers are supplied from overhead ducts through orifice plates as shown in Fig. 2. This control system allows cabinets to be opened for maintenance or individual racks removed, as here, without upsetting air distribution. Design pressure drop between first and last branches to cabinets is less than 0.08 in. WG

Consequently, the air pressure at the inlet to all the racks is approximately equal, and air flow into any one rack becomes a function of the size of orifice plate installed at that rack. Increased power requirements due to this imposed resistance are a small price to pay for the improved system performance.

Supply Air Control

At the highest permissible supply air temperature of 65 F, the air supplied from the equipment to the room is at 74 F, which is ample to maintain the 78 F maximum summer design temperature. The corresponding supply dew point temperature to maintain a maximum RH of 40 percent is 51 F.

This dew point is obtained without the use of reheat by employing a bypass system. Criteria established for supply air into the racks required that 52 percent of the air be cooled to 50 F. The resulting temperature of the air mixture is 65 F with a relative humidity of 60 percent.

At less than design loads, the bypass damper permits a greater percentage of outside air to bypass the cooling coil. If the relative humidity rises above 60 percent because of high moisture content in the outside air, the relative humidity controller will override the temperature controller, allowing less air to bypass the cooling coil by closing the damper. The temperature controller then repositions the steam valve at the bypass heater to maintain the dry bulb temperature of the supply air at 65 F.

Use Dual Filter Plan

In order to maintain the cleanliness required, all incoming air is filtered through a high efficiency unit designed to operate at 90 percent efficiency when tested with atmospheric dust in accordance with the Bureau of Standards discoloration test.

To prolong the life of the high efficiency filters, all incoming air first passes through standard washable-type filters to remove any coarse matter which might be present. A slight positive pressure is maintained within the building to prevent any infiltration.

Control Chiller Manually

Chilled water at 43 F is provided from a centrifugal chiller. This temperature can be raised or lowered by manually controlling the compressor. To obtain the required dew point temperature, the operator adjusts the chilled water temperature to suit the specific cooling coils. On any similar installation, this would be necessary since cooling coils are furnished in standard sizes, and the installed coil surface might be greater than the minimum required. ∓

Are air ions an overlooked quantity in air conditioned spaces? While the essentiality of air ions has not been firmly established, one could sense at the First International Conference on Ionization of the Air that the people studying the physiological effects of ions feel that atmospheric ion concentrations should be artificially restored in air conditioned and heated spaces. Here in a brief report of the meeting are some things you should know about air ions today.

Ions in the Air What's Their Significance?

LONG a controversial subject, ionization of the air and its physiological effects have been the subject of much research in recent years. Ions are present in the atmosphere in concentrations of about 1000 to 2000 per cc. This amounts to about one ion for every 10^{12} molecules. While present in such infinitesimal amounts, relatively speaking, their numbers can be measured. Instruments are available which permit measurement of small ion concentrations as low as 20 per cc.

It might be assumed that such relatively small numbers of ions as exist naturally in the atmosphere would have little if any effect on the human being. Yet as pointed out by Dr. W. F. G. Swann, director emeritus, Bartol Research Foundation of the Franklin Institute, in his address to the recent International Conference on Ionization of the Air, the response of the blood hound to the scent of an escaped convict, or that of the male of the human species to a few molecules of exotic perfume attest to the fact that trace substances in the air can produce significant reactions in mammals.

What is positively known about the physiological effects of ionized air environments on human beings? What problems are encountered in ionization research and how can consistency be brought into research and the reporting of results? These and other questions were considered at the conference which was sponsored by the American Institute of Medical Climatology and held at the Franklin Institute. Members of the medical and engineering professions concerned with evaluating the effects of ionized air presented a number of papers and discussed their mutual problems during the two day session.

What Is Ionization?

Radiation from naturally radioactive materials in the earth's crust and in the air, and cosmic radiation strip electrons from molecules in the air leaving positive ions behind, said Dr. C. W. Hansell, RCA Laboratories, in defining ionization. Positive ions are formed at the rate of about 10 per cc per sec. Recombination does not proceed at a very rapid rate because the returning electron often misses the positive ion. The electron ultimately may attach itself to another molecule forming a negative ion. Thus, he continued, the ion concentration increases with time until an equilibrium level is reached. An atmospheric ion density of 2700 positive or negative ions per cc would be considered a high natural level, he said.

Nearly all negative ions are oxygen molecules with an excess electron, according to Dr. Hansell. Positive ions are comprised of all gases with a positive charge, but research shows, he said, that carbon dioxide may be the most important positive ion. All ions form clumps of other molecules, especially water vapor, around themselves. Positive ions form the larger clumps. Hence, negative ions move at greater speeds than positive ions. In dry air, the small negative ion has a speed approximately 1.2 times that of the positive ion. As humidity increases, the speeds diminish

and approach each other and there appears to be less biological effect, he said.

That mobility of the ion — as indicated by speed — is a most important factor was supported by J. C. Beckett, president, Palo Alto Engineering Co. The oxygen ion which has high mobility, he said, has been observed to have beneficial effects on tissue whereas, the carbon dioxide ion identified by its lower mobility appears to have adverse effects. Mobility alone, however, is not the only factor to be measured in reporting air ion characteristics, he continued, as concentration and fluctuation also have a bearing on the observed physiological effects of ions.

How to Generate Ions

Various sources of ions exist and some have been used in research. Several sources are available commercially for producing ions in air conditioned spaces. The various sources of ions as given by R. Nagy, research department, lamp division, Westinghouse Electric Corp included:

1) *Corona discharge* — This method of producing ions is used and, of course, a common application is in electrostatic precipitation. Often times, a corona discharge will produce large particles carrying a number of charges. This may lead to erroneous measurements as the one large particle could appear to be a large number of small ions. A so-called sonic jet generator, which employs a corona discharge and an air stream at sonic velocity to produce large quantities of ions, was described by K. T. Whitby, assistant professor, mechanical engineering, University of Minnesota.

2) *Thermionic generators* — These employ a hot metal surface to [illegible] ions. Electrons are attached to the oxygen [illegible]ces to produce negative ions above 1600 F. Most molecules and impurities in the air become positive ions, however, when they strike and leave a hot surface above 800 F. Unipolar ions are produced by separating those of unwanted polarity by means of an electrical field.

3) *Ionizing radiation* — Ionizers employing radioactive materials such as polonium 210 and tritium are commonly used by researchers in the field. Materials which emit alpha or soft beta particles are considered the best suited for this type of ionizer at present. The tritium, which emits soft beta particles but theoretically is less efficient than those which emit alpha particles, is being used more often because it eliminates possible escape of radioactive material to the air. The ratioactive ionizer appears to be favored by researchers at present because of its nearly constant ion output. To obtain unipolar ions, electrical separation techniques are employed.

4) *Ultraviolet radiation* — While ultraviolet radiation does not have sufficient energy to ionize air in itself, it is used to generate ions by means of photoelectric effect. Ions are produced when electrons are ejected by photoelectric effect from clean metals surrounding the lamp. This type of ionizer produces only negative ions.

Where Ions Go in a Room

One problem facing the researcher and anyone who would use ions in general air conditioning systems is that of maintaining the desired equilibrium concentration in the room. P. Kranz, home care and comfort department, General Electric Co., coauthor with T. A. Rich, also of G.E., likened the production of small ions in a room to filling a sieve with water. "One knows there is leakage, but hopes to be able to fill the sieve even faster," he said. Three main losses when producing unipolar ions were given by Mr. Kranz:

1) Loss to the walls and other objects through space charge of the ion cloud. Repulsion of the space charge, when of the same polarity as the ions, causes the ions to move to the various surfaces.

2) Loss to walls and other surfaces by diffusion through a boundary layer.

3) Loss caused by collision of small ions with condensation nuclei which then become large ions with less mobility and energy.

Dr. Hansell listed smoke, accumulation of salt particles, dust, etc. as condensation nuclei which are effective deionizers. The greatest source of deionizers outdoors, he said, was the automobile, while the greatest source indoors was cigarette smoking. Because of the various influences indoors such as the high surface to volume ratio, the presence of condensation nuclei, and the deionization potential of air ducts, indoor ion concentrations are generally lower than those outdoors and there are relatively more positive ions in indoor air.

Recombination of positive and negative ions becomes significant as a source of ion loss only when ions of both polarities are being generated.

On the basis of their studies of rates of ion loss, Mr. Kranz concluded that even in ideal cases it would be difficult to achieve unipolar small ion levels above 5000 to 10,000 per cc except in small localized air streams.

Can Uniform Levels Be Achieved?

Achieving uniform concentrations of ions in a conditioned space is another problem facing those who use or study ionization. As noted by Dr. Swann, unipolar ions spread by repulsion and the density, therefore, decreases approximately as the square of the distance from the source.

Other factors which affect the distribution of ions in a room were given by A. H. Frey, General Elec-

tric Advanced Electronics Center. These include the shadow effect which could be likened to the shadow effect in radiant heat transmission, the potential of the subject and other objects in the room in relation to the potential of the ionizer.

While uniform ion levels might be desirable in air conditioned spaces, non-uniform ion distribution has caused no particular problem in research when ion concentrations were measured in the breathing zone at the point where the subject is located. Such measurements are generally made without the subject present to avoid any influence of his potential.

What Physiological Effects?

In a session devoted to physiological effects of ions, J. L. Worden, St. Bonaventure University, summarized the results of tests conducted there over a period of several years on small mammals. His generalized results were as follows:

1) An excess of 2000 ions per cc of one polarity produced measurable physiological effects in animals.

2) Negative ionization consistently caused an increase in blood pH in the animals. This is significant as pH is an indication of the ability of the plasma to absorb carbon dioxide.

3) In negatively ionized atmospheres, animals gained weight faster than those in natural or positively charged environments.

4) In negatively charged atmospheres, healing of open wounds proceeded more rapidly than it did in normal atmospheres but decreased in positively charged environments.

5) With an excess of 2000 negative ions per cc, animals recovered from shock more rapidly than those in other atmospheres.

6) Bacteria and mold growths were suppressed in ionized air and little difference was observed between the effects of positive and negative ions.

In a broad sense, Dr. Worden concluded, negative ions were stimulants and positive ions were either without effect or produced undesirable results.

In general, the various papers reporting physiological studies of ionization showed favorable results from negative ionization when patients were suffering from respiratory ailments such as hay fever and asthma.

Do Ions Effect Work Capacity?

Russian studies reported by A. A. Minkh, Stomatologycheski Medicinskij Institut, show a measurable increase in work capacity of a group of athletes who inhaled large quantities of negative ions 15 minutes each day. A two phase effect was observed in the subject's work capacity. During the first few days, work capacity decreased. Continued exposure to negative ions caused an increase in work capacity as the study progressed. At the end of 25 days, those exposed to negatively ionized air maintained a standard grip on a dynamometer 46 percent longer than the control group. After 25 days of negative ion treatment, the subject's dynamic work production as measured on a treadmill increased 59.7 percent.

It is interesting to note that objective tests such as blood pressure measurement showed no change. However, subjective effects such as tone, cheerfulness, etc. were experienced by the group exposed to negative ion treatment.

What's the Future of Ionization?

The physiological effects of ions are exciting but are not yet firmly established, said I. H. Kornblueh, graduate school of medicine, University of Pennsylvania. The question of whether an electric space charge is essential, he said, must remain unanswered at present. However, ionization is one of the discarded natural agents in outdoor air which may be needed by man.

In the desire to obtain quick relief indoors from the effects of weather, he continued, the engineers have overlooked ionization. Heating and cooling are not sufficient as ionization is required too. At least it will help, he said, though much must yet be learned about it. It has been proven Dr. Kornblueh said, that "ionization has a definite place in our environment."

Looking to the future, Dr. Kornblueh predicted that ion producing devices will be used to restore outside ion levels in air conditioned and heated spaces. Another future use of ions he suggested was in substerranean fallout shelters. The air could be freshened by ionization during standby with low ion production. Then ion levels could be increased as required to maintain the desired levels for comfort in the event occupancy became necessary.

Standardization of ion producing devices and the methods of testing and rating such devices was recommended by Dr. Kornblueh. He suggested that an independent organization for testing and rating purposes would be desirable and in so doing echoed sentiments others had expressed earlier.

To assure rapid progress in the field of air ionization he urged close cooperation between the medical and engineering professions. Additionally, Dr. Kornblueh said, the engineering profession must become familiar with the medical significance of ions and the medical profession with the principles of electrostatics if research is to be meaningful. ⫩

All papers presented at the First International Conference on Ionization of the Air will be published in the Proceedings of the Conference. The Proceedings will be published soon by the American Institute of Medical Climatology, 1618 Allengrove St., Philadelphia, 24.

A New Three-Zone, Integrated Design For Air Conditioning Commercial Buildings

The architecturally successful new glass-skin office structures have generated many new ideas in commercial air conditioning and zoning. One of the most interesting will be demonstrated in the Los Angeles Water and Power Office Building, now under construction, where engineers have chosen to combine a perimeter dual duct system with a unique integrated lighting-air conditioning system for inside areas. The latter uses return air to temper high velocity cold air in specially designed single-duct induction boxes. Here is a description of the design with comments on the important considerations and procedures involved.

By C. S. PERKINS
Albert C. Martin
and Associates
Architects and Engineers

A NEW general office building for the Los Angeles Department of Water and Power will provide space for more than 3000 employes currently working in a number of scattered locations. Two lower levels of the building will serve as a podium from which will rise a 15-story glass sheathed tower. Total floor area in the building will equal some 880 thousand sq ft.

Design Ideas

A number of interesting and some unique features will be incorporated in the air conditioning design: a three-zone (interior, exterior, perimeter) air distribution plan will employ conventional high velocity dual duct mixing boxes plus single (cold) duct induction

boxes; building heating water will be supplied by a split condenser heat exchanger design built around the refrigeration compressors; a reflecting pool atop the two-story building base will be used to dissipate more than one-third of the air conditioning heat load; air distribution and return will be via combination lighting-supply-return fixtures in the ceilings.

How Design Proceeded

The rectangular tower is oriented with the two short sides facing northeast and southwest. Because its location promises no future shading from adjoining buildings, solar radiation (to be discussed later) was a most important design factor.

Inside conditions of 75 F DB and 45 percent relative humidity are to be maintained under summer and winter design conditions of 95 F DB and 30 percent RH, and 35 F DB and 100 percent RH, respectively.

Three 1600 ton centrifugal chillers will supply cooling water at 44 F to the various fan and coil stations throughout the building. A roof-mounted cooling tower will serve two of the compressors, with the third connected to the spray pool water supply and return system.

Split Condenser Supplies Heating

Direct heating will be furnished only through a perimeter system. Heating water will be circulated through the secondary side of the chiller condensers, while at the same time cooling tower water to the primary side will be throttled back. Heat will thus be exchanged from the compressor refrigerant to the heating water, which will then be circulated to the perimeter "air curtain" coils only.

This perimeter system is a conventional high velocity dual duct arrangement, with mixing boxes installed above a hung ceiling at each level to furnish conditioned air through slot-type registers in the floor above. Air is discharged through the slots and up across the glass walls to compensate for heat gain or loss through the glass surface. Air is returned through grilles located in vertical blind soffits to mechanical shafts in the building core.

Interior Air Conditioning

All office spaces in the building are arranged on a 4 ft modular basis. Offices along the outside walls actually are "double-zoned," first with the perimeter system described above, and secondly with an overhead air distribution system. These spaces, therefore, comprise the "exterior" zone. A typical exterior zone covers an area of about 70 by 12 ft. Interior or away-from-the-glass zones measure about 40 by 30 ft, and are also designed around the 4 ft module.

An interesting and imaginative system of air distribution and return has been developed for the interior/exterior zones. The first consideration was the fact that 100 footcandles of light would be provided for general office areas, and twice that intensity in spaces such as drafting rooms. The generally mild Los Angeles climate, coupled with the fact that the perimeter system already discussed would compensate for solar effect, meant that at least some cooling would be required in the building's working spaces year 'round.

The modular office floor plan is complemented by a segmented ceiling in which alternate 4 ft panels are lighting fixtures and sound absorbent panels. In a typical interior zone, every third lighting fixture will serve a second purpose of air supply and return. Thus a good part of the lighting heat is disposed of before it enters the room, as return air is passed over the tubes and ballast.

The dropped ceiling acts as a return air plenum, and in addition houses specially developed supply air single duct induction-mixing boxes.

The single (cold) ducts deliver air at high velocity to these devices. Dampers in one end of the boxes allow a certain amount (up to 30 percent) of warm return air to be induced into the boxes from the plenum, thereby effecting proper tempering of the supply air, which is then delivered through the same lighting fixtures which serve also as return registers. Short duct sections pass the "unused" return air from the ceiling plenums to the vertical shafts in the building core, thence to the mechanical equipment rooms.

Outside Air Provision

An automatic return-outside-exhaust air damper system will provide 25 percent minimum outside ventilation air and exhaust return air to the atmosphere whenever the outdoor air temperature is below the return air temperature. This condition will prevail about 75 percent of the time. Excess air from the ceiling plenums will be mechanically exhausted through the roof.

All outside and return air introduced to the system will be passed through automatic pre-filters, then through electrostatic filters, and finally through carbon filters prior to entering occupied areas.

Special Use Areas

Those areas of the building such as computer spaces, conference rooms, etc., which will experience extreme or varying load conditions use the same basic air conditioning system but are separately zoned as required. Toilet rooms, janitor's spaces, and electrical equipment rooms are provided with exhaust systems which will allow a minimum of 12 air changes per hour. Exhaust systems will draw air into these

areas through door or wall louvers, or undercut doors. Kitchen and exhaust systems will receive make-up air from dining and serving areas by means of transfer fans.

Temperature Control

A central control console has been included in the design plans. This console will provide supervision and operation of all mechanical and electrical equipment through an electronic-electric control system. Complete temperature sensing and readjustment for outdoor air, return air, mixing air, space conditions, hot and cold deck plenums, supply and return hot water, chilled water, and condenser water, plus automatic start-stop of all mechanical equipment can be accomplished from this one location. Perimeter zones are controlled by exposure with outdoor temperature compensation; interior zones use space cooling thermostats only.

The Basis for the Air Conditioning Design

The preceding description of the final design plan for air conditioning a large commercial structure offers a good chance to examine some basic ideas on solar conditions, conduction, convection, occupancy, and light loads, and the effect the *time element* in such loads has on refrigeration requirements and zoning problems.

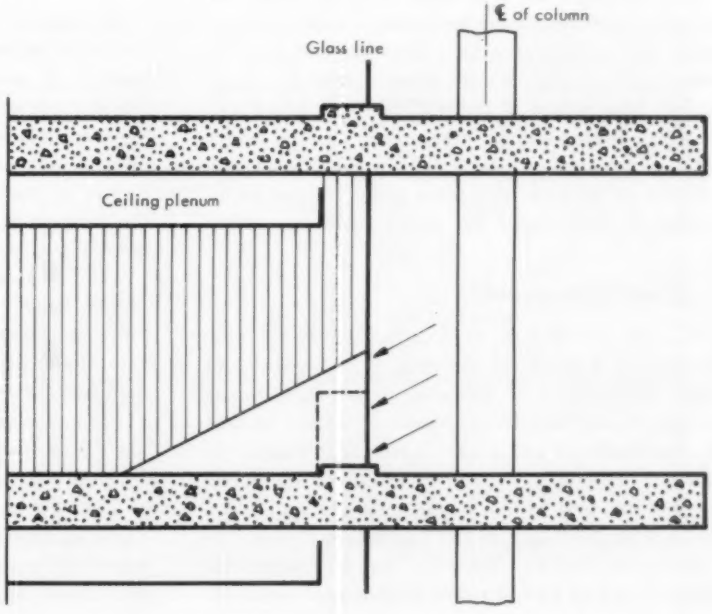
How Time Affects Load Calculations

Time is of course a basic quantity in design calculations. Generally, the time function of conduction and solar heat gains is super-imposed on the time functions of occupancy, lighting, and product load. The latter three are usually considered as constants for equal time derivatives of conduction and solar heat gain. This is somewhat fallacious because spaces such as conference and assembly rooms which are not used consistently introduce an additional time variable into our thinking — but since it is impossible to predict the simultaneous occurence of these sometimes-loads, machinery is usually sized to accommodate the maximum possible load, with any variation absorbed in the zoning and capacity control setup.

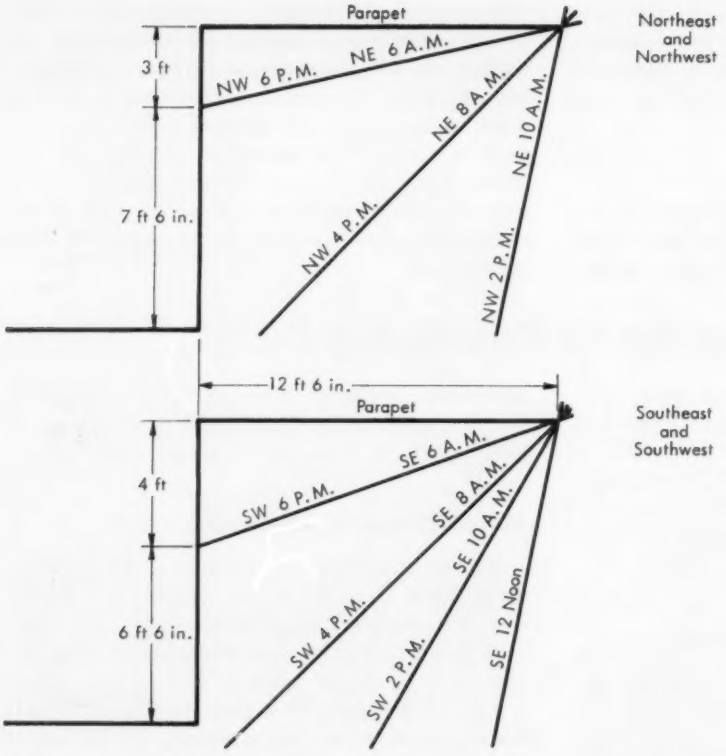
Solar Effect and Compensation

Having established the character of the building, as described above, let us first consider solar protection. We considered six possibilities: 1) a glass wall with no sun control, 2) vertical and partial horizontal control, 3) a vertical screen to filter all light before it reached the glass, 4) a projecting canopy which would provide at least partial shading for the skin at all times, 5) a combination of short canopy and screen, and 6) a horizontal screen with the skin in partial sun and filtered light.

Computations were prepared indicating the solar load as reflected in refrigeration tonnage, and alternative four (the projecting canopy, Fig. 1) was tentatively accepted. Such a canopy would impose no additional load through solar absorption if it were



1 PROJECTING CANOPY of concrete was selected as method which offered best combination of features to afford solar protection. Shaded area and arrows indicate "typical" degree of solar impingement



2 SOLAR impingement condition for December, calculated for various exposures and times, is expressed here as related to sun angle and shading effect of canopies. Such graphs indicated need for added protection of heat-absorbing glass

sufficiently extended so that the surface at each level were shaded by the one above during normal occupancy hours.

Solar computations were based on one hour solar increments for the months of March, June, September, and December on each of the four orientations. The results set a 12 ft 6 in. horizontal dimension for the canopy.

The condition for December (Fig. 2) shows the need for additional solar protection during working hours. Hence, heat absorbing glass was added to the concept; this change means, however, that the inside surface temperature of the wall has been raised and therefore outside ambient temperatures are no longer valid for conduction heat gains. In short, when calculating on the basis of the new glass, T must be increased to compensate for direct solar absorption.

Conduction, Convection

We will not attempt to describe exactly the generally-used methods of calculating heat gains and losses. Basically, it is necessary to use the familiar Fourier Equation for uni-directional transfer of heat by conduction, wherein the rate of heat transfer in Btu per hr equals thermal conductivity multiplied by the area and by the temperature difference, and divided by the length of the heat transfer path.

Similarly, we use Newton's Law of Cooling for transfer of heat by convection from a solid surface to a fluid (window to inside air); that is: the rate in Btu per hr equals the product of the film coefficient of convection heat transfer, the normal area of the surface, and the temperature difference between the surface receiving heat and the media (air) losing heat.

Radiation Factor

All surfaces with a temperature above absolute zero emit radiant energy. The basic radiant transfer equation is modified for net radiation between any two surfaces so that the rate of heat emission from the so-called "black body" or perfect emitter equals the product of a constant, 0.173, a factor involving geometry of surface plus surface characteristics, and the temperature difference (absolute to the fourth power) between the warmer and cooler surfaces.

Another modification is required to correct the "black body" value for the actual surface color. Since the temperature varies as the fourth power, a very slight increase in surface temperature rapidly increases the rate of radiant energy emission.

Various methods for combining all these functions have been proposed. Unfortunately, the relationship between solar altitude, transmission, and absorption of glass are so complex that a simple mathematical expression for the heat gain is impractical. We have found the graphical analysis prepared by Professor Hutchinson to be simple to use and sufficiently ac-

curate for most air conditioning work related to commercial buildings.

Equate Temperature, Occupancy

We have now introduced three solar time variable factors: the solar impingement due to orientation, the vertical variation in surface temperature due to solar shading, and the variation of solar altitude throughout the year.

Studies were made of Weather Bureau records indicating time and frequency of occurrence of high dry bulb temperatures. These were plotted, and indicated 4 P.M. as maximum. Similarly, low temperatures and their frequency were plotted, and it developed that minimum temperatures occurred generally prior to morning occupancy.

The personnel load was considered as constant from approximately 8 A.M. to about 4:30 P.M. (Some minor areas are occupied on a 24 hr basis, or 7 day week. Again the auditorium has an occasional occupancy both day and night, and cleaning personnel work in various areas during the night.).

The lighting load was computed at 6 watts per sq ft, with an optional increment to 9 watts per sq ft. Lighting also is considered as constant for a period preceding and paralleling occupancy.

Obviously, night lighting will be required for the cleaning crews, but the extent of that requirement is not yet fixed.

Graph Shows Final Loads

By plotting the various refrigeration loads, with time as the abscissa and refrigeration capacity (tons) as the ordinate, a picture of the building requirements was developed as shown in Fig 3. The tons of refrigeration for each of the elements comprising part of the total load are the total instantaneous values for an entire floor of the building for the time indicated.

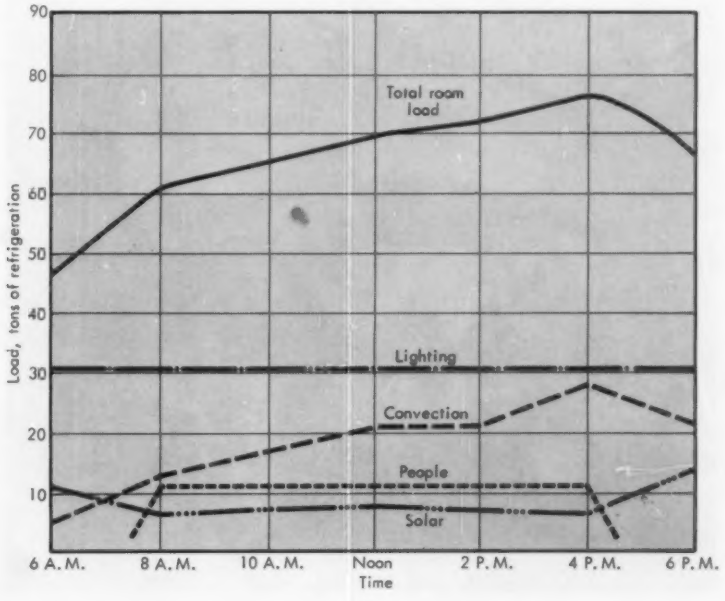
Addition of the components of the loads yields a total load for the peripheral area that peaks at approximately 4 P.M. There is also a load for the interior areas that appears to be constant and which coincides with the occupancy and light load, assuming that the variable load created by outside air temperature changes is ignored. We have elected to do this insofar as zoning is concerned since the effect of a change in outside air temperature is on the sizing of the refrigeration equipment rather than on the zoning for a particular space.

Final System Selection

All of the above considerations resulted in the selection of the relatively unconventional three-zone air conditioning design, and in the adoption of the single duct high velocity induction-mixing box plan for air treatment for inside office spaces.

It is well known that many modern commercial structures require interior cooling in various amounts year 'round. Especially since the advent of higher intensity lighting, solutions to the problem of providing a number of separate areas with adequate and precise conditioning can become not only complicated but expensive.

In the Los Angeles Water and Power building the use of return air to temper the constant temperature cold air affords a simplified layout, a substantial equipment reduction, and most important adequate and flexible zoning with economy. ⧺

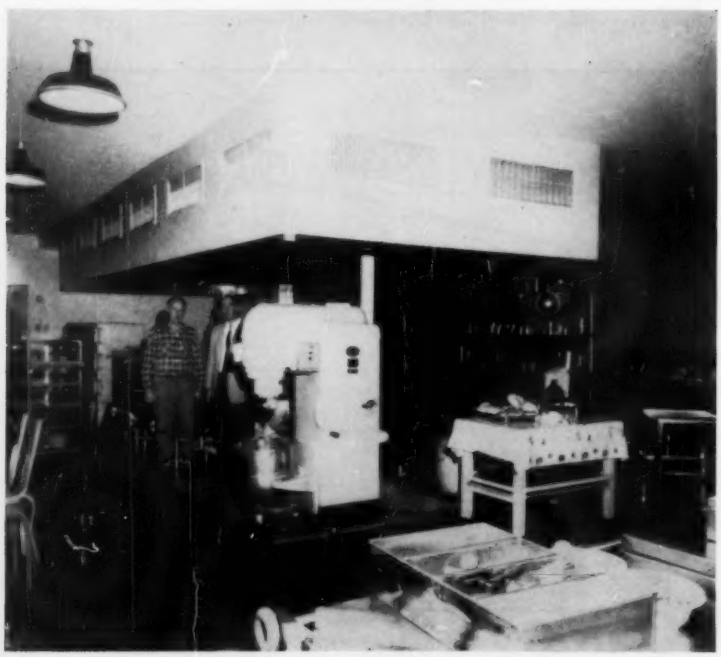


3 LOAD PLOT for various factors affecting coding requirements shows constant people and light loads throughout day, with solar and convection loads varying. Addition of four lower curves yielded total load curve above, showed that load would peak at about 4 P.M. This is plot for one floor of building

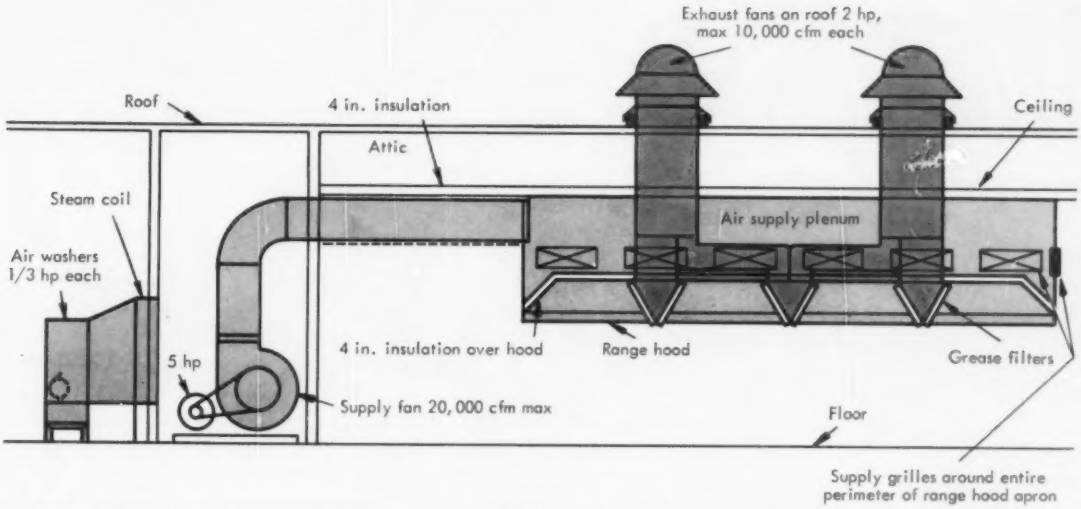
Here is an engineer's description of some design measures taken to provide automatic control of supply and exhaust systems in a large commercial kitchen. The problem is one of compensating for large variations in heat gain from kitchen equipment plus high or low outside temperatures, when a large volume of outside air must be introduced as makeup to replace air exhausted through range hoods.

In this system, an automatically controlled variable voltage regulator controls the speed of specially-wound supply and exhaust motors coordinately so that they perform in almost perfect unison. Thus, the capacity of the system is regulated in accordance with room temperature, outdoor air temperature, and the operation of heat-producing equipment.

Compact Control System Varies Air Supply, Exhaust for Commercial Kitchen



KITCHEN supply/exhaust system at Orange County (California) Juvenile Hall. Chief of Maintenance William Ware is at left, author at right. System is diagrammed in Fig. 1



1 SUPPLY-EXHAUST ARRANGEMENT of commercial kitchen ventilation system uses range hood centrally located above heat-producing equipment and "open" on all four sides. Exhaust air passes through grease filters, is emitted via roof fans directly to outdoors. Supply air is delivered through grilles around entire perimeter of hood. Design conditions are 90 F DB, 70 F WB and 38 percent relative humidity. Pair of slinger-type air washers produce adiabatic saturation to about 80 percent RH, reduce supply air DB temperature to about 75 F. Addition of 8 F design sensible rise results in 83 F DB temperature at 61 percent RH — acceptable conditions for commercial kitchens

By A. M. HAGLER
Mechanical Engineer

HERE IS a successful experiment which may promise an answer to a vexing problem for many air conditioning engineers.

The problem is how to control the volume of air supplied and exhausted to and from a space in order to coincide with an extreme variation in heat gain from operating equipment, while at the same time compensating for large variations in outdoor air temperature, when outdoor makeup air must be admitted in large volumes.

Such a situation can occur in air conditioning a variety of use-areas — in this case it involves a large commercial kitchen.

Demands Are Variable, Extreme

Here is the difficulty in more specific terms: commercial kitchens have the problem of extreme variations in heat input from batteries of open-top ranges, ovens, steam kettles, pressure cookers, etc. Concurrently, outdoor air must be supplied in large volumes to kitchens to replace air exhausted through range and dishwasher hoods.

It is therefore necessary to control the volume of air supplied and exhausted in a most accurate and efficient manner in order to coincide with the extreme variations.

Case In Point

The kitchen for the new Orange County (California) Juvenile Hall is a 300 meal facility with a maximum heat input (after deductions for diversity) of 350,000 Btuh.

Under maximum load conditions (3 PM on a hot summer day with the kitchen in full operation) 20,000 cfm of outdoor air is supplied to the space under fully automatic control, as makeup. Now let us imagine supplying this quantity of outside air at startup time — for instance 4 AM on a cold morning.

Standard Methods Fall Short

The usual methods of volume control such as dampering action by inlet vanes, face-and-bypass dampers, etc., when combined with automatic operation usually require large plenum arrangements or oversize ducts to house the dampers. In addition, roof-type exhaust fans are not easily adapted to this method.

For the case in question, we would have had to provide 20 sq ft of damper for the supply and an equal amount for exhaust in order to maintain damper velocities at conventional limits. As expected, the architect would contest the use of that much space, and would frown on the use of the roof for such bulk.

Looks At Motor Control

In our search for a more efficient method of interlocking and varying the supply and exhaust system volumes, we contacted Mr. Glenn Gillett, consulting engineer and authority on electric motor design,

Commercial Kitchen Ventilation Control

and asked if there was a practical way of varying the speed of an induction motor at a relatively economic cost.

It developed that such a motor, with a special winding, could be supplied. Motor speed could be controlled by means of a standard variable voltage regulator. Mr. Gillett pointed out that the torque-speed curves of this adaptation were uniquely well suited to fan speed control, and that due to the torque-speed curves of the blowers, the motors could be expected to operate well within the rated temperature rise over the entire speed range.

(We are aware of the fact that there are many types of variable speed motors available, but for this installation, the cost of incorporating most of these in a heating and ventilating system would have been prohibitive. The essence of this design was in the relatively low cost and the simplicity of adaptation to fully automatic control, plus the compactness of the package.)

Test For Motors Chosen

Tests were made on a gradual-acting control motor for the automatic adjustment of the speed control unit, and it was found that it furnished more than enough torque to operate the speed control. Besides, we found that the control motor could be connected directly (without gearing) to the shaft of the variable voltage regulator, or speed controller.

Look For Long-Run Economy

There are many commercial kitchen ventilating designs that prove inadequate when transferred to another job, and we do not suggest that this method will have the lowest installation cost for any and all requirements. We do say that this design will be more economical than others designed to equal this performance.

Design Details

Fig. 1 shows the physical arrangement of the Juvenile Hall facility. Note that the range hood is centrally located and open on all four sides.

About 50 percent of the heat load could be deducted for well-hooded appliances, for a net cooling load of 175,000 Btuh. The 20,000 cfm makeup air volume mentioned earlier was required in order to hold to a maximum temperature rise of 8 to 10 F, as:

$$175{,}000 \text{ Btuh}/8(1.08) = 20{,}000 \text{ cfm approx.}$$

Design conditions are 90 F DB, 70 F WB, and about 38 percent relative humidity, with the RH being less than this much of the time in summer months.

Use Evaporative Cooling

In view of the above, we decided to incorporate an evaporative cooling system, using a pair of slinger-type air washers at 10,000 cfm each, controlled in steps. Adiabatic saturation by this method, to about 80 percent RH, will reduce the DB reading to approximately 75 F, and the effective temperature equivalent to 72.5 F; probably less due to the fact that air motion would be appreciably greater than the 15 to 25 fpm upon which the standard chart is developed. It should be noted that generally speaking, people who work in commercial kitchens like high velocities.

If we add the 8 F design sensible rise to the 75 F DB and 80 percent RH conditions, the result is 83 F DB and 61 per cent relative humidity. This is well within the boundaries of the comfort zone. For commercial kitchens, it is more than acceptable. Only mechanical refrigeration, we think, would improve such conditions, and owing to the large outside air requirement, such a solution would likely be impractical for most kitchen installations.

How System Works

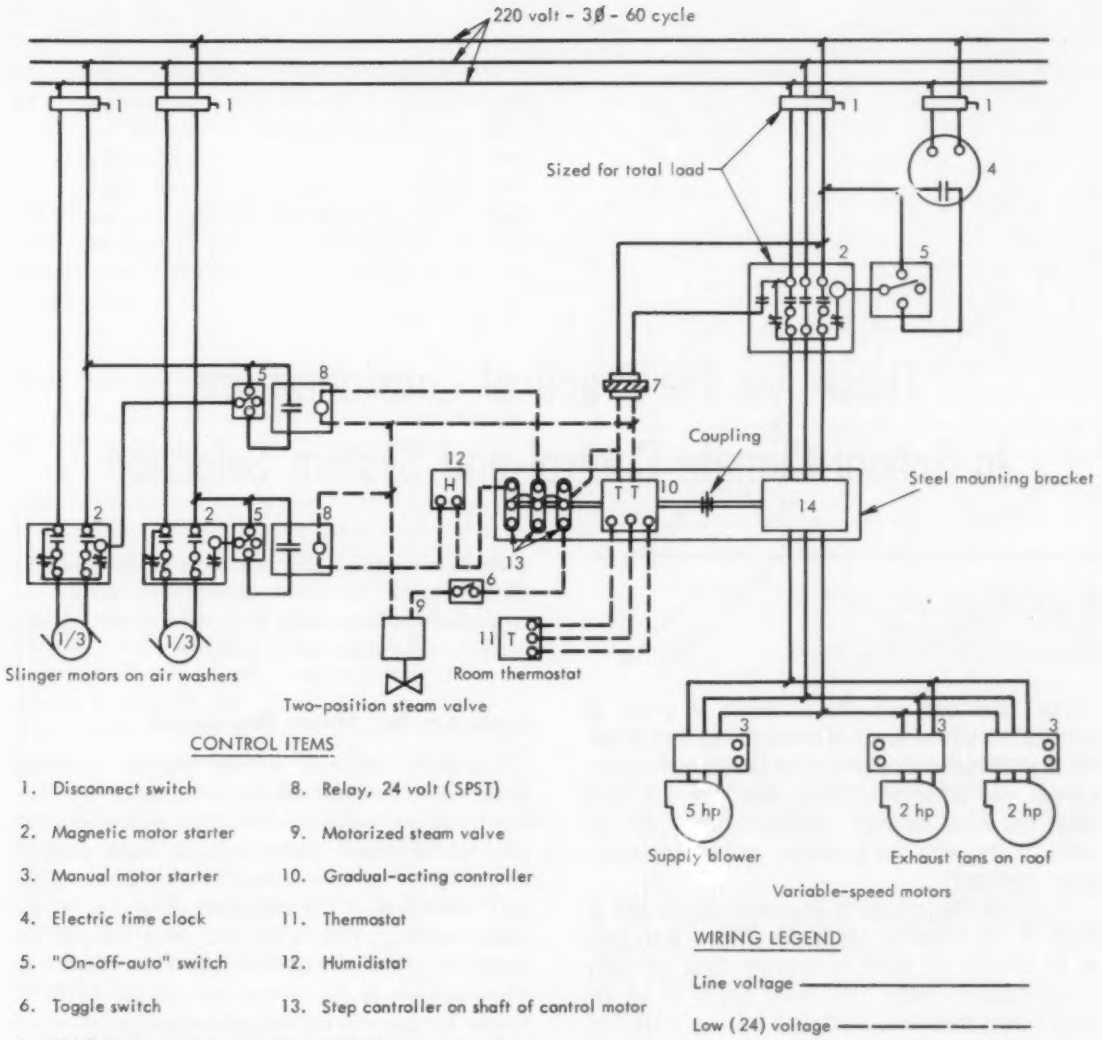
A brief explanation of the operational sequence will illustrate the effect of automatic control.

The system is triggered by a time clock to start at 4 AM, approximately one hour before employees arrive. In winter, outside temperatures at this hour may be 30 to 35 F, but room temperatures may be quite high due to the residual heat in the kitchen area.

When cold air is admitted, however, the gradual-acting room thermostat acts to cause the control system to reduce air intake to the minimum — 30 percent of total capacity.

Heating Starts Automatically

When the voltage regulator has rotated to the extreme low point, the mercury end switch for heating control makes contact and admits steam to a tempering coil. The differential adjustment of this end switch is such that contact will be maintained through 30 percent of upward travel of the voltage regulator. For the next 40 percent of increase, the system operates on ventilation air only. At the 70 percent point, the first cooling end switch makes



2 CONTROL METHOD for supply/exhaust system described in text starts with automatically controlled voltage regulator which in turn controls the speed of specially-wound supply and exhaust fan motors. Gradual-acting controller thus prevents supply/exhaust "tug-of-war" since fans operate almost as though on a common shaft. Complete air and heating-cooling control is provided over entire range of outside and inside temperature conditions

contact and activates No. 1 air washer. The second air washer is started at the 100 percent mark.

On cold mornings, the system will remain at reduced capacity until the employees arrive and start the ranges and steam kettles. Then the thermostat will increase the air capacity. This capacity, however, will remain constant at any one point whenever the room thermostat is "satisfied."

Maintain Adequate Low-Volume Velocity

Care was taken to design for range hood velocities high enough at maximum volume so that the velocity at reduced capacity would be sufficient to provide satisfactory results. Performance requirements for the range hood are negligible during the lower capacity periods.

Operation Shows Good Results

This system has been in operation through two summers and two winters, operating seven days a week. During this time, we have checked the performance quite frequently, and we, and the occupants, are most pleased with the results.

Though the writer's experience has been with speed control of three-phase induction motors, a satisfactory method of adapting single-phase motors to fan and blower applications has also been developed. ≠

These Are the Practical Considerations In School Climate Control and System Selection

By MAURICE J. WILSON
Educational Consultant
Carrier Air Conditioning Co.

How "standard" are the problems of winter or year 'round school air conditioning? Are they different from those encountered when designing for commercial and other structures? What are the facts about the need for high ventilation rates? Are we really dealing with the problems, or are they oftentimes confused?

These are the questions discussed clearly and in detail in the following pages. Mr. Wilson then goes on to identify the kinds of systems most generally being installed today, tells what ought to be expected from them and presents a relative evaluation of schoolhouse air conditioning practices.

SO MUCH has been accomplished during the past half-century to improve thermal and atmospheric conditions in the American schoolhouse that any move toward better quality in this area should be preceded by a survey to determine what remains to be done.

According to educators, chronic over-heating and uneven ventilation are the most commonly encountered deficiencies of systems in general use today. This viewpoint is so widely held that it may be confirmed by an interview with almost any school administrator.

It was statistically confirmed in 1960 by a poll of school superintendents in all parts of the nation. Of the more than 300 who responded, 70 percent declared that over-heating is responsible for educational inefficiency some or much of the time during the normal school year. And 63 percent said that existing ventilation services failed to produce continuously the desired results. No other environmental factors except noise (condemned by 71 percent of the respondents) received more critical votes.

Facts Are Not Always Recognized

Consulting engineers actively engaged in school work will not be surprised that over-heating is a common cause for complaint. They are well aware that good school climate control demands much more attention to cooling than heating in every season of the year, regardless of the geographical location of the school building. This is the first point made in the discussion of design considerations in the chapter on school systems in the current issue of the ASHRAE *Guide*. Yet it is still not fully understood by all school board members and taxpayers, whose thinking quite naturally is influenced by substantial annual fuel bills for heating.

Several factors peculiar to school buildings and their use make year 'round heat dissipation a requirement of all system designs. Except for theaters, auditoriums and churches, the schoolhouse is the most densely occupied of all common structures. Classrooms are about three times as heavily populated as the average office. Electric lighting also is intense and is used almost continuously. Usually, classrooms are located on the exterior, where large glass areas on southern, western and eastern exposures transmit big amounts of heat when the sun is shining. This is true in all seasons.

How Problem Develops

As soon as the children enter the building in the morning and the lights are switched on, the amount of heat generated within the classroom more than

offsets heat losses through walls, glass and roof except on days when the temperature is below about 25 F. When the weather is warm and heat is flowing by transmission into the classroom, rather than out, the cumulative effect is more severe. And the effect of sunlight and outside conditions become even more critical unless steps are taken quickly to combat them. All of this is graphically illustrated in Fig. 1, which shows net heat gain or loss in a typical classroom according to prevailing outdoor conditions and use of the room.

Heat Gain Is Cumulative

The classroom analyzed by the chart is the familiar 30 pupil room of 800 sq ft. It is located along an exterior wall of a one story school of conventional design, construction and glass area. It is assumed that a temperature of 70 F is being maintained within the room; hence this is the neutral, or heat balance point.

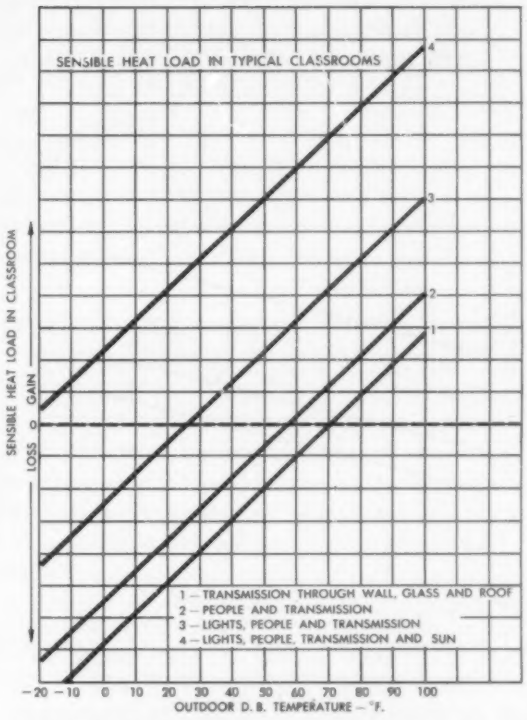
To interpret the chart, read along the broken horizontal line identified by the zero at the left. Any extension of the numbered curves above the zero line indicates a net heat gain; any extension below indicates a net heat loss. The curves numbered 2, 3, and 4 represent the cumulative effect of adding people, lights and sunlight to the classroom heat load while taking into account the simultaneous transmission of heat (in or out), depending upon the outdoor temperature shown on the scale at the bottom of the chart. It is important to note that transmission (Curve 1) is the only thermal factor capable of reversing itself. All the other factors are always positive, adding heat to the classroom as they occur.

Chart Shows Severe Requirements

A little study of the chart quickly reveals what the engineer is up against in his effort to maintain thermally acceptable conditions in the classroom. When the room is occupied but the lights are off, he must be prepared to offset heat gain whenever the temperature outdoors is above 56 F. With both people and lights to contend with, the breakeven outdoor temperature is 25 F. And with the room exposed to sunlight, occupied, and the lights on, heat will start to mount whenever the outdoor temperature is higher than 25 degrees below zero.

Naturally, the first line of defense against excess classroom heat calls for the use of cool outdoor air, if any is available. This so-called free cooling (not completely free, since it entails use of ventilating fans and air filters) proves to be perfectly satisfactory so long as the outdoor temperature is not higher than 60 F.

Above that point, the quantity of heat generated within an occupied and electrically lighted classroom


SENSIBLE HEAT LOAD IN TYPICAL CLASSROOMS
SENSIBLE HEAT LOAD IN CLASSROOM
GAIN
0
LOSS
1 — TRANSMISSION THROUGH WALL, GLASS AND ROOF
2 — PEOPLE AND TRANSMISSION
3 — LIGHTS, PEOPLE AND TRANSMISSION
4 — LIGHTS, PEOPLE, TRANSMISSION AND SUN
−20 −10 0 10 20 30 40 50 60 70 80 90 100
OUTDOOR D. B. TEMPERATURE — °F.

1 CUMULATIVE EFFECT of heat adding factors (transmission, people, lights, sun) on need for heating or cooling of typical classroom can be seen by "reading" Curves 1 through 4. With 70 F as balance point, continuous heat gain is apparent

cannot be completely offset by outdoor air introduced at the maximum volume permitted by classroom standards and the economics of the project. Under these circumstances, classroom temperature will surely rise above normal design conditions (70 to 72 F in winter, 76 to 78 F in warm weather) unless cooling by refrigeration is employed.

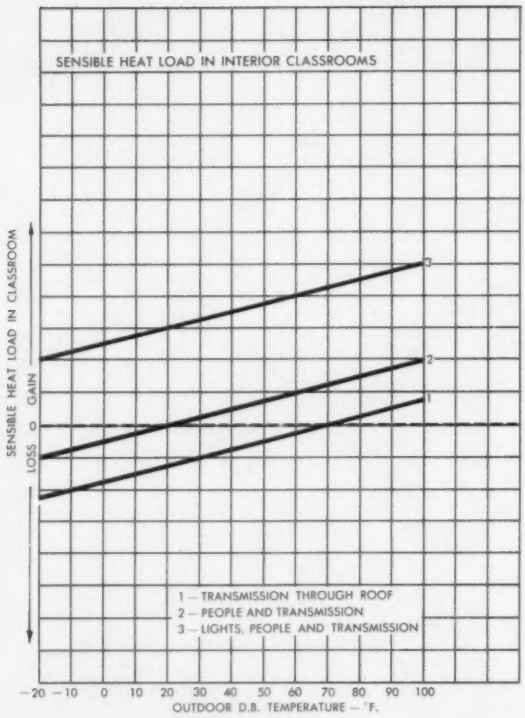
Open Windows Won't Do

The other alternative is to open windows. However, for the purposes of this study, we are going to assume that windows remain closed. Window ventilation is uneven and hard to control. Usually one third of the class is chilled in order to obtain comfortable temperatures for the remaining two thirds. Also open windows usually admit dust, pollen, industrial soot, noise of traffic, airplanes and barking dogs to interfere with the teacher's message.

If windows open only at the bottom they tend to leave undisturbed the hot air above the open area unless there is a breeze to ventilate forcibly.

The Other Half of the Problem

Fig. 1, which explains so clearly why a school of conventional design poses stiff cooling problems when


SENSIBLE HEAT LOAD IN INTERIOR CLASSROOMS
SENSIBLE HEAT LOAD IN CLASSROOM
LOSS 0 GAIN
1 — TRANSMISSION THROUGH ROOF
2 — PEOPLE AND TRANSMISSION
3 — LIGHTS, PEOPLE AND TRANSMISSION
−20 −10 0 10 20 30 40 50 60 70 80 90 100
OUTDOOR D.B. TEMPERATURE — °F.

2 INTERIOR CLASSROOM loads, illustrated by these curves, differ substantially from exterior room counterparts of Fig. 1. Sun factor is eliminated. Transmission is reduced since it occurs only through roof

it is occupied, also supplies the reason for substantial fuel bills for heating. Note that with the building empty, lights off and the sun not shining (the night situation), heat gain or loss is governed only by transmission.

Even if building temperature is permitted to fall to 60 F at night, which is common practice, transmission loss occurs the instant the outdoor temperature drops below that mark. And with the big glass areas encountered in conventional school design, transmission outward is rapid. The same holds true for weekends and holidays, except that the sun will help cut fuel bills during the daylight hours of those periods. Unquestionably, the usual Christmas holiday alone adds considerably to the fuel bill of most U. S. school districts.

When Classrooms Are "Inside"—

Some schoolhouses today are being designed so that classrooms are located in the interior, separated from exterior walls and exterior glass by a corridor or other rooms. This arrangement changes considerably the thermal characteristics of the classroom, as Fig. 2 illustrates.

In this instance, only three curves are required to portray heat gain or loss, since the effect of sunlight has been virtually eliminated. At the same time, the curves are much flatter than those depicting heat gain or loss in a conventional exterior room because transmission takes places only through the roof and therefore is much reduced.

Hence, peak heating and cooling loads are also reduced, and the capacity of the cooling and heating plant can be much smaller.

Actually, when an interior room is occupied and the lights are on, some cooling will be required in all seasons of the year. Again, this may be accomplished by introduction of outdoor air whenever the outdoor temperature is 60 F or less.

In general, engineers treat the heat flow characteristics of exterior classrooms without windows as though they were interior rooms. Exterior rooms with less than conventional window areas (strip windows, for example) will have thermal characteristics some where between those shown in the charts for the inside and large glass area rooms.

Why An Argument on Ventilation?

Classroom ventilation requirements also are frequently misunderstood. This comment from Chapter 47 of the authoritative ASHRAE *Guide* explains the actual situation: "With regard to ventilation, code requirements vary from acceptance of natural ventilation, such as obtained by opening windows, to a requirement of mechanical supply of a specified quantity of air, which sometimes is as high as 30 cfm of outdoor air per occupant. The variations in quantity of outdoor air specified usually are due to lack of a uniform understanding of the reason for ventilation."

Research has established that ventilation air is required, not to replace oxygen for breathing, but to dilute body odors which become intensified in densely occupied spaces.

In all probability when school administrators complain about classroom ventilation, they are dissatisfied with odor control. Objectionable odors may be controlled by absorption, masking, or dilution, with the latter the most common schoolhouse practice. Contaminated classroom air is proportionately diluted when outdoor air is in sufficient quantity to obtain an acceptable odor threshold. Obviously the outdoor air itself must be free of smoke or other contamination to produce the desired results. Note also that air for odor dilution purposes need not necessarily be outdoor air. Recirculated room air that has been made free of odors will serve the purpose as well and may reduce system costs.

What Are Real Ventilation Needs?

Fig. 3 presents the quantitative ventilation story in a nutshell. Curve *A* gives the quantity of outdoor

air required to maintain proper oxygen content; curve *B*, the quantity of outdoor air required to limit carbon dioxide to a healthy minimum (0.6 percent); curve *C*, the quantity of odor-free air required to dilute to an acceptable degree the odors generated within the room. All air quantities are expressed in cfm per pupil.

The most important point made by this chart is that just 4 cfm of outdoor air per pupil is ample to meet oxygen and carbon dioxide needs. The odor dilution requirement on the other hand is much bigger. The latter ranges from a minimum of 11 cfm of odor-free air per pupil to a maximum of 31 cfm, depending upon the cu ft of air space provided by the classroom for each pupil and upon the class group itself.

The hatched area of the chart delineates the effect of air space per pupil on the odor dilution requirements. As the chart indicates, the air space may range from 225 cu ft per pupil to 300 cu ft per pupil in average classroom situations.

Another Variable: Pupils Themselves

The make-up of the pupil group provides a variable of some importance. The prevailing dietary and other habits of the school population should be evaluated and plotted within the range of the dotted lines at the lower and upper limits of the hatched area in the chart also.

In the particular case illustrated by Fig. 3, curve *C* has been plotted for a school population of about average background. For this group, a classroom of 800 sq ft with a 10 ft ceiling and 30 pupil occupancy will require 540 cfm of odor-free supply air to maintain an acceptable odor threshold (800 × 10 ÷ 30 = 266 cu ft per pupil; from the chart 18 cfm per pupil × 30 pupils = 540 cfm for classrooms). Of this amount only 120 cfm need be outdoor air to satisfy oxygen and carbon dioxide requirements (4 cfm per pupil × 30 pupils), provided the remaining 420 cfm of recirculated room air has been treated to remove odors.

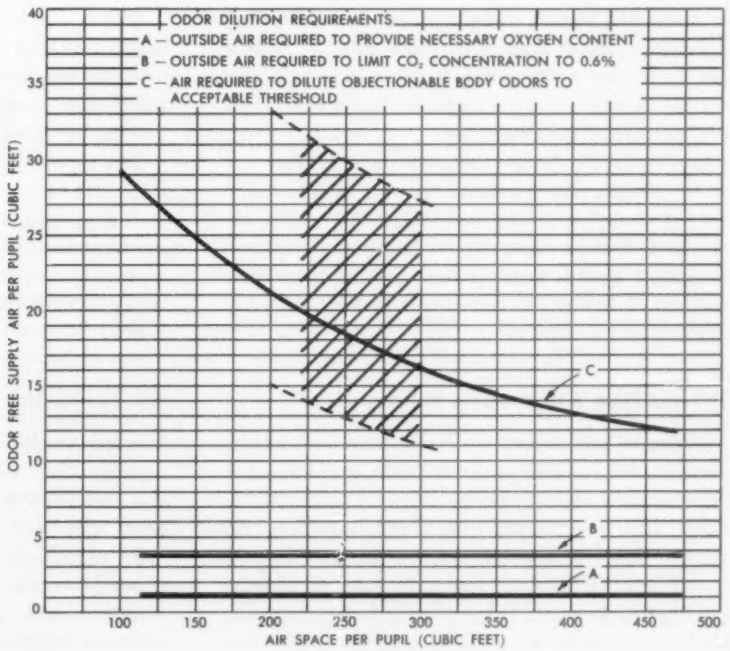
Need for Cooling Remains

Supply air of this quality and quantity will completely satisfy the classroom's ventilation requirements, but it will fall far short of its cooling needs. In all probability, an exterior classroom of this size and occupancy will require about 1200 cfm of cool supply air to handle the load satisfactorily (the exact amount to be determined by an on-the-spot load calculation).

In winter this can be outdoor air for its cooling value; in warm weather, refrigeration will be required. In any event only 120 of the 1200 cfm total must be outdoor air, to meet ventilation needs, provided that at least 420 cfm of the recirculated air is properly treated to remove odor content.

Benefits of a Realistic Approach

This approach to the overall problems of schoolhouse climate control has the merit of pinpointing the basic objectives of a first class heating, cooling and



3 VENTILATION requirements for oxygen needs, carbon dioxide limitation, and odor dilution in typical classroom are plotted here, illustrate fact that odor dilution is by far most stringent need. Hatched area indicates effect an increase in space per pupil will have in reducing ventilation for odor removal requirement

ventilating system. It helps uncover the cause of deficiencies that are presently reported by school administrators. And it enables the engineer to explore various cost saving alternatives in system selection and system design. For example, study of a particular project may reveal that use of a central spray coil apparatus to wash odors out of recirculating air may cost less than increasing the supply of outdoor air, and provide equal results.

Next, Specific Requirements

Other problems facing the designer of school systems include maintenance of acceptable air motion and air distribution without drafts, effective air cleaning, simple but positive temperature control in individual rooms, provision for heat when and where needed and adequate control of noise and humidity.

Air motion, which may be anywhere from 25 to 50 fpm, should be maintained at a constant rate and in a pattern that prevents temperature stratification between floor and breathing zone. Distribution should effectively neutralize the down draft effect so prevalent in winter in exterior rooms with large glass areas. There should be a means of cleaning both the outdoor air and recirculating air.

Temperature, Humidity, Costs

Temperature, the most important factor in human comfort, should be maintained at the desired level when the room is occupied and with minimum fluctuation. The noise contribution of the system, particularly in the frequencies that interfere with speech, should be within the well defined limits set forth by ASHRAE. Relative humidity has a minor effect on human comfort when it is held within the reasonable limits. It is interesting to note, however, that survival of most common airborne bacteria is lowest at 50 percent relative humidity.

Above all, the designer must keep a weather eye on the budget, not only from the standpoint of first cost but also of operating and maintenance costs. He has the difficult assignment of providing an atmosphere that assures comfort and well being without creating "laboratory" conditions that are neither necessary nor desired.

Investigation Will Suggest Solutions

When the engineering specialist examines schoolhouse heating, cooling and ventilating problems as a whole, certain basic decisions begin to suggest themselves. The fundamental over-heating problem, for example, tends to rule out systems that rely heavily on wet heat in occupied spaces because of undesirable "flywheel effect". Odor dilution brings into consideration types of systems that provide at all times relatively large volumes of odor-free air.

The desirability of using outdoor air to maximum degree for cooling, an economy measure, also points to selection of a large volume air system. Effective air cleaning, simplicity of operation and service and good system noise control all favor selection of a plant which centralizes major apparatus and moving parts.

And today, more than ever, prudence dictates that a system that initially provides only heating and ventilating be of a type that converts to complete air conditioning at low cost at any future date.

Current Practices

There are several systems that satisfy these requirements with varying degrees of success. Some are relatively new, others are old, but all are being installed in school buldings.

The systems most often considered today by the engineer for this specific application are as follows:

1) All-air, single duct, normal velocity, constant volume with reheat.
2) All-air, dual conduit, high velocity, one constant and one variable volume.
3) All-air, double duct, high velocity, constant volume.
4) All-air, double duct, normal velocity.
5) All-air, single duct, normal velocity with multizone central assembly.
6) All-air, single duct, normal velocity, variable volume (50 percent reduction).
7) Package equipment.
8) Unit ventilators.

Which one is best for a particular school depends upon a number of factors, many of which are purely local in nature. An analysis of their relative functional and economic merits should prove helpful in making the final decision.

Selection of the heating, cooling and ventilation system for a specific school building properly starts with a functional analysis. It is concluded by matching functional fitness to available dollars. The best type of system will be the one that assures the greatest functional potential at a cost that is within the budget.

Six Things the System Must Do

What are the basic functions of a system that is capable of providing an ideal atmosphere and thermal environment for teaching and learning? Engineers who have studied this question classify system tasks as follows: 1) Control of temperature within prescribed limits; 2) Dilution of odors to an acceptable threshold; 3) Removal of dust, pollens and other airborne particles; 4) Control of harmful bacteria;

TABLE 1 — FUNCTIONAL EVALUATION of schoolhouse heating, air conditioning, ventilating systems discussed in text, as determined by panel of practicing engineers. Evaluation is on the basis of an assignment of "10" to a system which performs any of the listed functions "perfectly," with lesser numbers assigned according to the extent to which this ideal is approached. FIRST number in each case applies to the system as evaluated for use in interior rooms. SECOND number, in parentheses, applies to evaluation of system for use in exterior rooms.

System number	Type	Temperature	Odor dilution	Air cleaning	Germicidal treatment	Air motion	Humidity	Noise control
1	Single duct, normal velocity, constant volume with reheat	9(9)	9(9)	9(9)	9(9)	9(9)	9(9)	8(8)
2	Dual conduit, high velocity	9(8)	7(6)	9(9)	8(8)	7(6)	8(8)	6(5)
3	Double duct, high velocity, constant volume	9(9)	9(9)	9(9)	9(9)	9(9)	7(7)	7(7)
4	Double duct, normal velocity	9(9)	9(9)	9(9)	9(9)	8(8)	7(7)	5(5)
5	Single duct, normal velocity with multi-zone assembly	9(9)	9(9)	9(9)	9(9)	8(8)	7(7)	7(7)
6	Single duct, normal velocity, variable volume (50 percent reduction)	7(6)	8(5)	9(9)	8(8)	5(5)	6(5)	6(5)
7	Packaged equipment	7(7)	3(3)	4(4)	3(3)	8(8)	4(4)	4(4)
8	Unit ventilator	9(9)	4(4)	5(5)	3(3)	8(8)	6(6)	7(7)

5) Maintenance of acceptable air motion and a uniform air pattern; 6) Maintenance of relative humidity within currently acceptable comfort standards.

Seventh Contribution: Noise

In performing these desired tasks, all systems will contribute some background noise to the classroom. This may be of no consequence if the noise introduced is of low and level intensity and within a frequency range that does not interfere with normal conversation. Otherwise it will be objectionable. In any event noise contribution must be included in the list of tasks performed even though it may not be a desirable one.

Note that the term "ventilation" does not appear in the list of seven tasks. This omission has been deliberate. All popular systems are capable of supplying the 4 cfm per pupil that is required to maintain proper oxygen and carbon dioxide levels. The odor dilution requirement is the significant one in connection with ventilation.

Control of harmful bacteria, feasible today although seldom accomplished because of cost, has been included in the list of functions because so many educators and health authorities have expressed great interest in it. New and more economical central system methods, approaching the stage of commercial availability, indicate that this function warrants consideration now, even if only from the standpoint of planning for the future.

Engineers Rate Designs

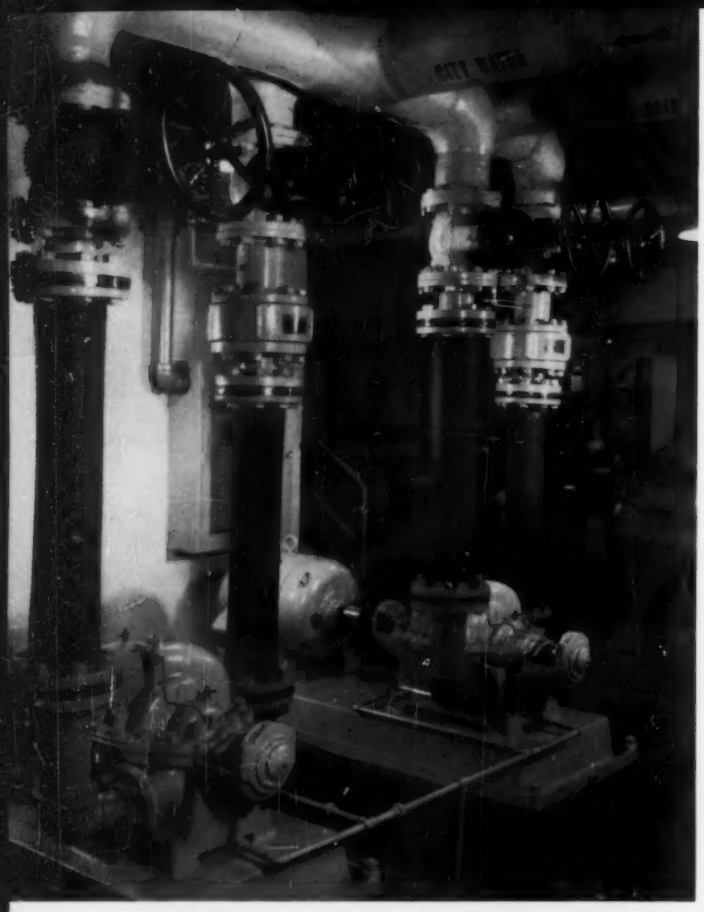
Can all types of systems perform the seven basic tasks with equal facility? Obviously, they cannot, even when each one is designed to its full potential. Since system selection begins with functional analysis, it is necessary to rate each system under consideration in terms of its capability to perform each function. This has been done by a panel of experienced engineers with the results appearing in Table 1.

Here the functional evaluations have been limited to the 8 systems, although a similar evaluation might be easily made for any others. The rating method is based on a theoretical score of 10 for a perfect performance capability in any one of the seven basic functions. In the opinion of the panel of engineers, no system today deserves a score of 10 for any function, although many scored 9 in one or more categories. The ratings given are based on the assumption that each system will be applied in terms of present day concepts, *i.e.*, the manner in which most designers apply them as a matter of good professional practice.

Be Sure to "Weight" Requirements

One other point. While it is true the seven functions, when properly performed, add up to an environment that promotes maximum human activity and well being, not all of the seven tasks make an equal contribution to this overall goal. Recent studies by the American Society of Heating, Refrigeration and Air-Conditioning Engineers and others prove that some of the functions are more important than others in the creation of a comfortable healthy atmosphere. For example, it is now known that control of temperature is a much more significant comfort factor than control of humidity, providing the latter does not get completely out of hand. ≠

A subsequent article by Mr. Wilson will deal with the costs of owning and operating the various systems discussed here for schoolhouse use, relative to the performance expected and attainable from each.



When and How Flexible Rubber Connectors Can Help Reduce System Noise, Vibration

By ROBERT L. SWENSON
Vice President, Engineering
General Rubber Corp.

Engineers working with heating, piping, and air conditioning installations are continually faced with the problem of controlling or eliminating the transmission of noise and vibration from reciprocating and rotating equipment to the building structure and occupied spaces.

Rubber connectors (pipe and expansion joints) can offer a workable solution to this problem when properly selected and installed.

Here are a series of tips on where noise and vibration come from, how they are carried, and the practical use of flexible rubber connectors to reduce or eliminate both.

WHILE the control of noise and vibration is an overall system problem, its solution demands that it be treated as two basically separate problems:

1) The elimination or containment of the vibration and noise generated by moving components of the mechanical equipment, and

2) The design and fabrication of the duct system towards the end of reducing noise transmission to occupied spaces.

This discussion will be confined to the first of these.

How and Why Noise Develops

The primary mechanical sources of vibration and noise within air conditioning systems are the rotating and reciprocating components of the pumps, compressors, chillers, fans, motors, etc. If these units could be machined, balanced, and installed perfectly, the problem would nevertheless be present. The effects of erosion, abrasion, and corrosion will in time pro-

duce some imbalance in the best equipment, and lead to the generation of vibration and noise.

The greater the imbalance, the greater the vibrational energy developed, and the greater the possibility that vibration and noise will be transmitted to occupied spaces.

Solution Is Practical Isolation

In reducing noise from machinery, the general principle followed is to isolate the mechanical equipment so as to block all paths of vibration and noise at the source. This prevents the transfer of vibrational energy to surfaces large enough to communicate such energy to the surrounding air in the form of acoustical radiation.

In general, the amount of sound transmitted through air by moving parts is negligible compared to that conducted by vibration through the foundation, supports, and connected piping. It is therefore good practice to insert materials of different specific acoustical resistance between the moving parts and the foundation supports, and piping. All machinery with moving parts should be isolated from its surroundings, and for proper effect this isolation must be complete.

Transmission Is Multi-Directional

Isolating the equipment from the floor or foundation is not enough. Rigid pipe lines of the system will offer broad paths for transmission, through metal-to-metal contact between the equipment and piping, to the piping supports, and thereby to the building structure and to the surrounding atmosphere.

Flexible rubber connectors correctly installed in the pipe lines can be a most effective means of insulating this noise and vibration path.

Why Rubber Stops Transmission

Because of the basic characteristics of rubber-fabric construction, flexible rubber connectors perform the function of stopping this transmission in two distinct ways.

First — the dampening of the transmission of sound energy across any interface is in inverse relation to the acoustic impedance of the two materials joined at the interface. Acoustic impedance is defined as the product of density (lb per cu in.) and the velocity of sound in the material (in. per second).

Fortunately, in a steel-rubber interface the ratio of the two acoustic impedances is about 1000 to 1, corresponding to a reduction in the amount of energy transmitted to a value of less than 1 percent of the original. It is this fact, for example, that enables the steel-rubber-steel motor mounts in automobiles to eliminate almost completely the transmission of engine noise to the chassis.

Secondly, the velocity of sound within the flexible connector walls is considerably less than that of the material in the adjacent pipe, whether it be steel, cast iron, or other. This is shown in Table 1.

As in the case of noise, vibration caused by the mechanical equipment is reduced by the damping action of the flexible connector. Rubber-like materials, some more than others, have extremely large vibration damping coefficients in relation to metals.

Expansion Joints

Flexible rubber, spool-type expansion joints perform a function similar to that of straight-through rubber pipe. While the two overlap somewhat in use, the expansion joint, with its built-in arch or arches, is intended primarily to absorb relatively large degrees of motion in the short face-to-face dimension of the joint itself. Thus it serves to prevent damage to

TABLE 1 — ACOUSTICAL IMPEDANCE, defined as the product of material density times the velocity of sound in the material, is important consideration in determining methods by which sound is to be isolated. Greater the ratio between impedances of two materials in contact, the greater will be the sound isolating properties of the installation. Relative impedance, in last column below, is based on impedance of rubber being equal to one

Material	Sound velocity, in. per sec	Density, lb per cu in.	Acoustical impedance, lb per cu in. per sec	Relative impedance
Steel	206,500	0.283	58,400	550
Copper	140,400	0.320	45,000	425
Cast iron	148,800	0.260	38,700	365
Lead	49,800	0.411	20,400	190
Glass	216,000	0.094	20,300	190
Concrete	198,000	0.072	14,200	134
Water	56,400	0.036	2,030	19
Pine	132,000	0.0145	1,910	18
Cork	19,200	0.0086	165	1.6
Rubber	2,400	0.0442	106	1.0

TABLE 2 — PRESSURE LIMITATIONS for rubber expansion joints for various pipe sizes and various uses, at maximum working temperature of 180 F

Size (ID), in.	Vacuum only, in. Hg	Pressure only, psig	Vacuum & pressure, psig
1, 1½, 2, 2½, 3, 4	30	150	90
5, 6	30	125	90
8	30	125	85
10, 12	30	115	85
14	30	75	60
16, 18, 20	30	60	45
22, 24, 26, 28, 30	30	50	40
34, 36, 40	30	40	40
42, 44, 48, 50, 54	30	40	40
56, 60, 62, 66, 72	30	40	35

pumps, compressors, etc., through pipe motion.

There are some restrictions on the use of rubber expansion joints, especially in the larger sizes, related to the amounts of internal pressures which they can withstand. Table 2 shows some average allowable working pressures for these devices, based on a maximum working temperature of 180 F.

It should be noted that within the pressure ranges for which they are intended, the expansion joints, being flexible and possessing the characteristics of rubber, function satisfactorily in the elimination of sound and vibration transmission. Standard rubber pipe has somewhat broader limitations, and should be capable of handling working pressures up to about 250 psi in diameters up to 12 in.

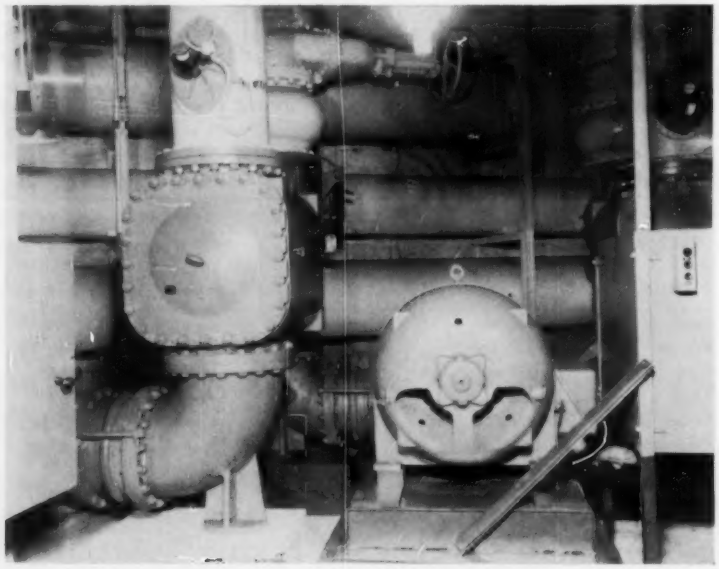
Extreme Lengths Are Unnecessary

In the past, engineers tended to use long lengths of flexible rubber pipe, with the idea that length played an important part in noise and vibration absorption. Recent experience has shown that this theory is not true, and that in fact over-long lengths may themselves cause complications.

Since they are flexible, long pieces tend to bow out of line when subjected to high internal pressures. This is particularly evident when the metal pipe is rigidly anchored or when control units are used on the rubber pieces. Although bowing will not affect the performance of the unit, it may be unsightly and may alarm the operating engineers. Rubber pipe will perform at peak efficiency if proper lengths are used, and longer pieces are unnecessary. Table 3 shows typical recommended lengths for various pipe sizes.

Problems of Year 'Round Use

The increasing incidence of year 'round air conditioning systems over the past few years has created new problems in designing flexible rubber connectors. Previously, rubber connectors were used primarily on chilled water lines, and standard rubber and duck construction was adequate.



EXPANSION joints of flexible rubber perform function similar to that of rubber pipe, plus absorption of relatively large degree of motion. Here, control units prevent excessive elongation

TABLE 3 — STANDARD LENGTHS for flexible rubber connectors, based on pipe size

Pipe size (ID), in.	Pipe with IPT coupled fittings, in.	Pipe with full-faced flanges, in.
3/4	18	—
1	18	18
1 1/4	18	18
1 1/2	18	18
2	24	18
2 1/2	24	18
3	36	18
4	36	24
5	—	24
6	—	24
8	—	24
10	—	24
12	—	24

TABLE 4 — PERMISSIBLE MOVEMENT in flanged flexible rubber connectors, based on pipe size, length of connector

Pipe size (ID), in.	Flange-to-flange length, in.	Extension, in.	Compression, in.	Transverse, in.
2	18	3/8	1/4	3/8
2 1/2	18	3/8	3/8	3/8
3	18	3/8	3/8	3/8
3	24	1/2	1/2	1/2
4	24	1/2	1/2	1/2
4	30	1/2	1/2	1/2
5	24	1/2	5/8	3/8
5	30	1/2	5/8	1/2
5	36	5/8	1/2	5/8
6	24	1/2	5/8	3/8
6	30	1/2	5/8	1/2
6	36	5/8	1/2	5/8
8	24	1/2	3/4	3/8
8	30	1/2	3/4	1/2
8	36	5/8	5/8	5/8
10	24	1/2	3/4	3/8
10	30	1/2	3/4	1/2
10	36	5/8	5/8	5/8
12	24	1/2	3/4	1/4
12	30	1/2	3/4	3/8
12	36	5/8	3/4	1/2

With the introduction of dual systems, the maximum temperature was raised — first to 200 F, and more recently to the 240 to 250 F operating range.

New materials have been developed to meet these new requirements, including new synthetic fibers and synthetic rubbers. It should be emphasized, however, that the maximum allowable temperature, employing materials currently available, is about 250 F.

Installation Tips

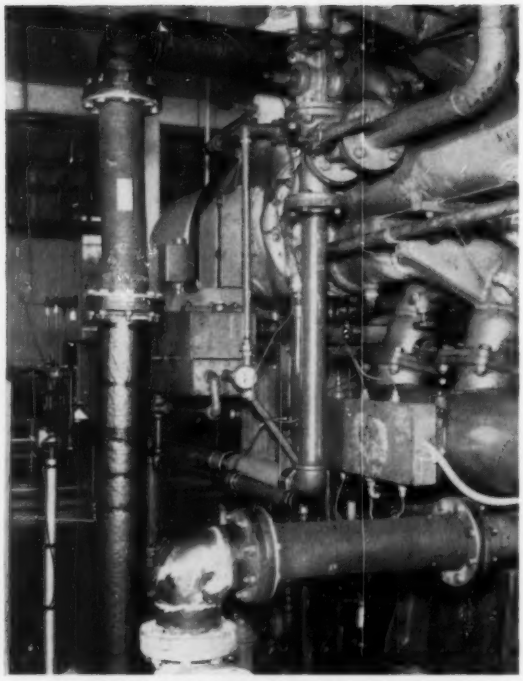
Although flexible rubber connectors have been used for a number of years, there still exists some confusion as to how they should be installed.

It is absolutely necessary that the rigid metal pipe on both ends of the connector be properly anchored in order to eliminate the danger of excessive elongation. Table 4 gives typical safe elongation values for various sizes and lengths of pipe. Rubber connectors have been installed too often in systems where improperly anchored lines caused the connectors to elongate far beyond the design limitations. This of course is not a safe practice.

In cases where proper pipe anchoring is not possible, and where considerable elongation can occur, it is important that a control unit be installed in order to prevent elongation beyond practical limits.

When "Stretch" Is Desirable

Generally, the flexible connector should have the same overall length as the span between the rigid piping. For long spans, however, or for high operating pressures, the connector should be slightly shorter



SLIGHT MISALIGNMENT of rigid metal pipe can be compensated for by rubber connectors, as on this line from refrigeration compressor

than the span, bolted loosely in place, and stretched as the seal is formed. This will reduce bowing and sagging which might occur due to excessive elongation of the part.

It is also important that these connectors be installed in relatively straight lines to eliminate undue twisting. Since they are flexible, however, some misalignment can be taken up by slight distortion at the flange.

Don't Hesitate to Tighten

Flange bolts should be tightened until the rubber flange bulges slightly between the face of the pipe flange and the metal retaining ring. Bolts should be tightened in equal steps in order to maintain uniform tension and alignment. Some mechanics are reluctant to take up on the bolts sufficiently. This can result in an initial leak between the flanges of the rubber connector and the pipe flanges when the system is first operated.

Operate, Then Check Again

It is important also that the bolt tightness be checked after initial operation of a few days duration. As any rubber-like material takes a set after the initial period of compression, bolts may loosen and result in a break in the seal. It is also considered good maintenance practice to check the bolts periodically during the first year of operation.

Isolate Piping from Structure

Metal piping isolated by means of rubber connectors and free of vibration may be rigidly anchored. However, since noise can also be created by sharp bends in the piping or at the fittings or valves, the safe practice is to always isolate the piping from the building structure by means of vibration isolation hangers. Whenever tie rods are required for resilient mounts, rubber or neoprene washers or bushings should be used to eliminate metal-to-metal contact.

Proper Mounting Methods

A rigid floor by itself will not eliminate undesirable vibration. Suitable vibration-absorbing means must also be employed. A practical method is to mount the pump, compressor, or motor on a concrete block, which in turn is mounted on vibration isolators resting on the floor or foundation. The block, weighing two or three times as much as the equipment, decreases the movement of the unit and improves the isolation quality.

This is particularly important in the case of standard motors and lightweight pumping units, since the unequal loading of pump and motor can cause coupling misalignment when resilient material is applied under the feet of the pump and motor.

Water Hammer, Stress Control

Besides serving to reduce or eliminate noise and vibration transmission, flexible rubber connectors can offer the additional advantage of absorbing pulsations of the water itself through a diaphragm "breathing" action — thus giving positive water hammer control.

The flexibility of the rubber material will also reduce the amount of stress transmitted to the equipment as piping is subjected to thermal expansion and contraction. ≠

When using rubber connectors —

Be sure to watch pressure, temperature limitations.

"Overlong" units are unnecessary; shorter pieces have been found to do the job.

Anchor rigid pipe on both sides of the connector.

Match the length of span and the length of the connector (for high pressures, connector should be slightly shorter than span).

Install in relatively straight lines.

Tighten bolts until rubber flange bulges slightly; operate; then check bolts again.

Central plenums of various types which are used in modern low pressure commercial-building air conditioning systems can provide excellent flexibility, efficiency, and zoning capacity if properly designed with adequate controls.

Once the choice of the basic system is made[1] a great deal will depend upon the more subtle techniques of coil placement, damper operation, instrumentation, and so forth. Here are a number of suggestions and explanations aimed at helping the engineer to get the most from the central plenum arrangement.

Get the Most From Your Central Plenum Air Conditioning

By F. F. STEVENSON
Design Engineer

ADEQUATE air treatment-air distribution for the office or similar commercial building has to begin with a well designed air treatment center. At this point, the necessary air mixing, cooling, heating, humidification or dehumidification, and filtering will be largely accomplished, excluding any supplementary heating or cooling which may be carried out in the various use-areas of the building, as described in our earlier articles[1].

Start With the Plenum

Whatever form the conventional low pressure air distribution system may take — whether as a single large unit serving the entire building or as a number of smaller stations for the various zones — the operation of the central plenum arrangement is critical to the success of the system.

The design and sizing of mechanical components such as chillers, boilers, fans, coils, etc., is a subject apart. We will concern ourselves here only with the subject of moving air, from inside and outside the building, to a central plenum; mixing it in proper proportions, and distributing it through the ducts to the work areas.

[1]Two earlier articles in this series covered basic fundamentals in designing low pressure air systems for commercial type buildings: *The Essential Factors in Cooling Load Calculations*, September, 1961, and *How to Select an Air Treatment-Distribution System*, October, 1961

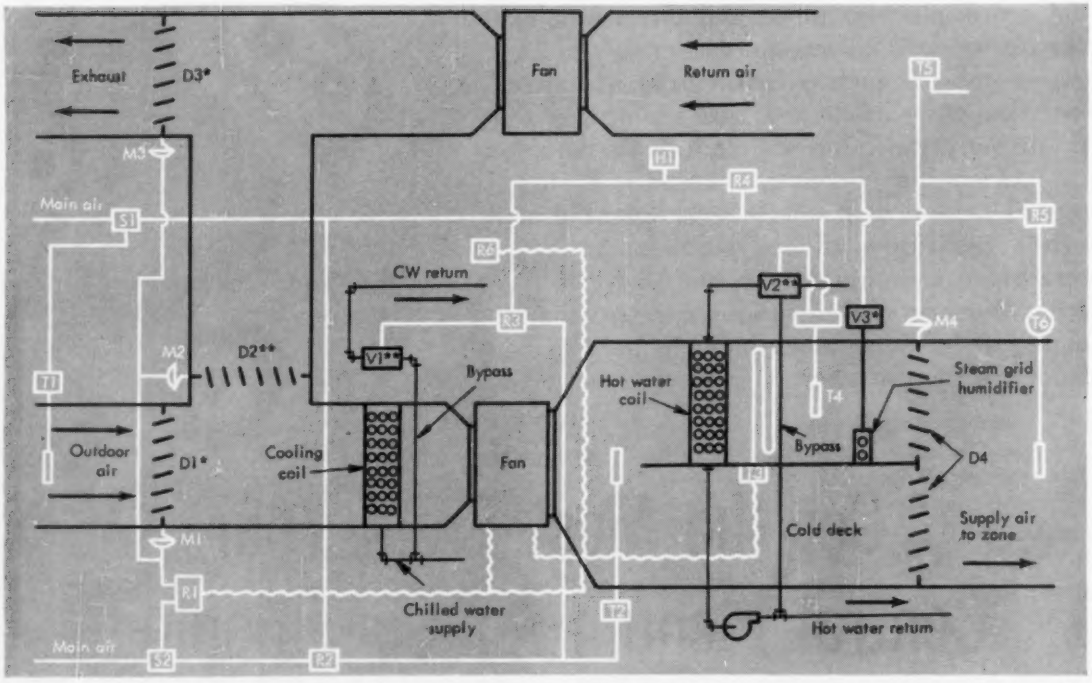
The "Economizer" Plenum

The economizer type of central fan and coil station (Figs. 1 and 2) is the ideal arrangement for efficiency in meeting the varying demands for a number of zones, each of which may demand a different supply air condition at the same time. The chief advantage of this plenum lies in its ability to use varying amounts of outside air, up to 100 percent, to decrease the load on the mechanical heating and cooling equipment during those times when outside air is at such a temperature as to be useable in the system with little or no treatment. Here are some notions on how to get the most from your central plenum design.

Fan Type May Vary

Either single inlet or double inlet fans may be used. With the latter, a straightaway plenum design can be used, which is sometimes convenient in fitting the system to the building. When double inlet fans are used, however, the overall efficiency of the air moving space will be reduced somewhat due to higher entrance losses. Allow an extra 10 percent or so in sizing for fan losses when using this arrangement.

In any case, the mixing areas should be reasonably large to afford a good blending of outside and return air. A perforated baffle plate installed downstream



1 HOT WATER SYSTEM. Thermostat (T) 1 is reverse acting, 2, 4, 5, and 6 direct acting, 3 electric. Humidistat H1 is reverse acting. Valves (V) 1 and 2 are normally open**, valve 3 is normally closed*.

When fans are started with the summer-winter switch (S1) on winter setting, relay R1 gives control of main dampers D1, 2, and 3 to thermostat T2, located in plenum downstream from supply fan. Damper motors M1, 2, and 3 are subject to T2, as is cooling coil valve V1. When outside temperature rises to 60 F, D1 and D3 are wide open and D2 is closed, with system operating on 100 percent outside air. At 65 F, summer cycle begins and T1 adjusts dampers to admit minimum outside air.

Again on winter cycle, low limit thermostat T3 (electric) will stop fans if plenum temperature falls below preset point, as in case of malfunction of heating coil. V2 maintains proper temperature off heating coil under control of T4, which is reset by T1 in accordance with outside temperature.

Humidistat H1 acts on valve V3 to control flow of steam to humidifier. Relay R6 will close V3 when fans are stopped.

Damper motor M4, under control of zone thermostats (T5) modulates mixing dampers D4 to hold design space temperature. Low limit thermostat T6 will stop fans if duct temperature falls below preset point.

On summer cycle (65 F and above) T1 puts system on minimum outside air, closes V3 (humidifier) and makes low limit thermostats inoperative. V1 (cooling coil) is controlled by T2 to hold design temperature off coil at 59 to 65 F. T4 modulates valve V2 to maintain proper temperature in hot deck, air from which is used to mix with cold deck air for reheat.

Humidistat H1 will be put on summer setting, to act on V1 for dehumidification

of the return and exhaust air intakes will also help make the air flow uniform.

The duties of the two fans in an economizer plenum can be summarized as follows. The return-exhaust fan works against the resistance of the return air circuit on the intake side, and may at any time do one of three things:

1) Exhaust all return air through the exhaust outlet,

2) Deliver all return air to the equipment section of the plenum, or

3) Exhaust part of the air and deliver the rest to the plenum.

Meanwhile the supply fan is working on its inlet side against the resistance of the filter, coils, and any other equipment to develop enough pressure to push the air through the supply duct and out the supply air outlets. In Figs. 1 and 2, the supply fans are working against coil resistance on both their inlet and outlet sides.

There is an important relationship which exists between the discharge pressure developed by the return fan and the suction (negative) pressure created by the supply fan. As the outside air intake is located at the entrance to the equipment plenum, enough negative pressure must be developed at this point to draw in an adequate volume of outside air. But this point is downstream from the return-exhaust fan and subject to its discharge pressure. Consequently, at this point of outside air intake, the static pressure of the air delivered by the return air fan should be kept at zero, even though the fan is creating enough pressure to drive return air through the exhaust outlet.

To solve this dilemma, enough resistance must be

"built in" the return air passage to use up all or most of the pressure in the air going to the equipment space.

Exfiltration Rate Is Important

In connection with the mixing of return and outside air, remember that in modern, tight buildings the exfiltration of supply air through windows and doors and other openings may not exceed 10 percent of the total supply volume, while in old buildings which are "loosened up," exfiltration may exceed 20 percent.

If a minimum mixing of 25 percent outside air is desired for a new-building system, then, some way must be found to exhaust the extra 15 percent. The economizer plenum, which can exhaust any required amount, will handle the problem. An alternative solution is the use of local exhaust fans mounted in suitable places; or simple louvered exhaust openings with dampers may be used. Exhaust fans or dampers may be automatically controlled by static pressure regulators; however, it may be difficult to achieve a proper balance with such devices, depending upon the design of the air flow pattern.

How Air Loss Occurs

Exfiltration depends on two factors: the velocity of the outdoor air and the static pressure within the building. The greater the velocity of outside air against a wall, the greater will be the interior pressure required to force the air out.

A "standard" inside pressure of 0.05 in. WG may be difficult to attain in old structures with loose windows and doors. This pressure value equates with an outdoor air velocity of about 900 fpm, or 10 mph. At the same time, it will be easier to exfiltrate air through an older building in order to make room for the needed ventilating air — and harder to build up the necessary pressure to overcome the effects of outside air velocity.

Proper Return Duct Sizing

Continuing with the supply/return air problem, it should be noted that return air ducts should be sized, not to match supply ducts, but rather for a volume equal to supply air minus exfiltrated and/or locally exhausted air; all volumes taken at design load.

Filter Placement, Treatment

The location of the main plenum filter is open to some choice. Some designers place the reheat coil ahead of the filter. This used to be necessary because the oil contained in the widely-used oil-type filters functioned poorly at low temperatures. Now, however, most such filters will operate in cold air without much trouble.

At any rate, the choice still exists between before-and-after-coil filter location. If the filter comes first, the coil is kept clean, but it may be uncomfortable to service the filter in cold weather with the fan running. For operational purposes, the filter-first arrangement helps to improve air mixing ahead of the coil.

Filters can be placed on the blow through side of the fan so as to prevent dust and dirt from infiltrating the plenum chamber between filter and fan.

Plenum Operations

Let us consider two typical zoning plenums (Figs. 1 and 2) which will illustrate some of the problems and solutions in plenum design and control. Each is of the twin deck type, with a single draw through intake and a split (hot and cold) discharge. The two fans shown in each system give economizer-type operation. Fig. 1 shows a system using hot water for heating; Fig. 2 one with steam coil.

Operating costs for such systems will be high on the average, since all air must be cooled and then at least some of it reheated much of the time. Moderate first costs and ease of control make such designs very popular, however.

The hot water system is shown without a preheat coil. This arrangement is used frequently when large volumes of return air will be used in cold weather. When large volumes of outside air are to be used in winter, however, a preheat coil should be used.

Systems Meet Critical Demands

Note again that in the two arrangements shown, all air is treated by the cooling coils. This is an essential point in installations with high latent loads, or where humidity is critical.

The control arrangements shown are set up to indicate the kind of precise regulation that can be obtained with this type of twin-deck plenum installation. Such precision might well be required on certain industrial treatment jobs, where humidity control is essential. Other ultra-sensitive applications, for instance computer rooms, would also be served well with such a system. Something less than the maximum control arrangement shown might be acceptable for purely comfort installations.

For many comfort cooling applications and/or jobs where the WB temperature will not be too high, the cooling coils might be placed in the cold decks, making the plenum 100 percent blow through. In that case, air used for reheat in the various zones is not dehumidified, but for non-critical installations that may

not be necessary. First costs for a straight blow through system will be less, as will operating costs.

Air off the heating coil in the hot deck must be furnished within a wide enough temperature range to satisfy demands during all seasons. Typically, a spread of 75 to 110 F or higher would be provided, and a master thermostat used to reset the plenum thermostat controlling the heating coil. The master thermostat may be located outdoors or in the return plenum.

Where Can Heating Coils Be Placed?

This is a good time to consider the possible locations for the heating coils, and further, the heating medium to be used.

A hot water coil (Fig. 1) lessens the danger of coil freeze-up, and in addition should provide smoother and easier control, particularly when the load is slight. Steam has a constant temperature for a given saturated pressure — at 5 psig steam temperature is 227 F and does not vary. Hot water temperature variation from say, 140 F to 240 F is easy to achieve, which gives the heating coil much greater flexibility.

Fig. 1 also shows, however, that even with a hot water heating coil, steam is often used for humidification.

Considerable choice is available for locating the preheat coil besides the main plenum location shown in Fig. 2. It may be placed in the outside air intake, covering the entire area of the duct section. Where winters are cold, this location demands two one-row coils, since freeze-up is always a problem. Each row should be controlled with a separate valve; the one for the leading row two-position and set to open when outdoor air temperature falls to 34 F. A thermostat downstream from the coil should control the valve to the second row.

Or, One Coil, Two Valves

Another arrangement would be to use a single two-row coil, fed by two modulating valves placed in parallel — one to handle two-thirds of the load and the other one-third. Control action is then as follows: assuming a design plenum temperature of 58 F, when the temperature falls below this point, a plenum thermostat downstream from the coil acts to open the smaller valve in a modulating manner. This will suffice in mild weather. As outdoor temperature continues to fall, reaching 45 F, an outdoor thermostat opens the larger valve in a modulating manner, and since the larger valve by itself can supply enough steam to carry the load, the plenum thermostat closes the smaller valve. When outdoor temperature falls to 33 F, the larger valve will be wide open, and if the temperature drops markedly past that point, the smaller valve will open again.

A single coil section, as shown in Fig. 1, combines the functions of preheat and reheat. However, the average two-row coil, assuming standard face velocities and using low pressure steam, may not be able to heat −10 F air to much over 100 F, and if the design calls for air temperatures higher than this value, such an arrangement cannot be used and another row must be added.

One advantage in using high pressure, high temperature steam for a given leaving air temperature is that it is often possible to use a smaller coil face area with higher air velocity, thus effecting a saving on the initial cost. However, since more steam must be used, operating costs will be higher.

Under some conditions, the use of higher pressure steam may enable the designer to use a one-row coil instead of the two-row unit he would have to use with a lower pressure.

The increased quantity of steam used for a high pressure application means more condensate to drain off. Also, due to the larger temperature difference, the condensate collects more quickly, and with automatic control, valve operation is more intermittent. Due to the high temperature, standard coil air relief devices cannot be used with high pressure steam, so pet cocks are usually employed.

Other Coil Locations

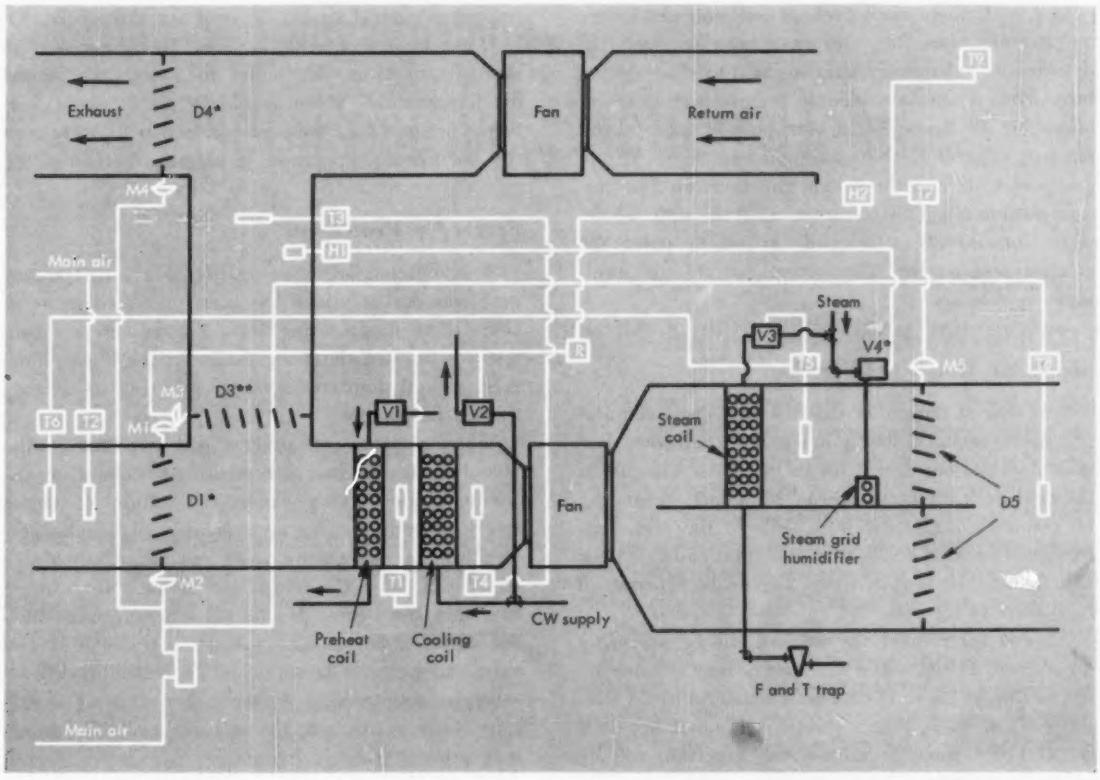
The preheat coil may be located in the plenum downstream from the return air duct (Fig. 2), at which point the coil heats the mixture of outside and return air. This method requires a larger coil, to cover the entire plenum cross section, but due to the relatively lower temperature rise required, a one-row coil may handle the load.

Another location for the preheater is in the return air duct, at which point the coil will heat the return air to a temperature high enough to use as a mixer in heating outdoor air to the desired level. There is no freeze-up danger with this arrangement, and if return air can be brought in the plenum from below or through the side, good mixing can be achieved. Such a setup is ideal for a hot water coil.

Finally, two preheat coils might be used; one in the outside air intake or duct and the other in the return duct. In mild weather, the latter, served by a modulating valve, would go on first. As outside temperature falls, the outside air coil, served by an on-off valve, would come on the line, and the return air coil would be shut off, then reactivated as outside temperature continued to fall.

Humidification Methods

A steam grid humidifier is placed downstream



2 STEAM SYSTEM. Thermostat (T) action can be summarized as follows:

T1 (plenum) controls preheat coil valve V1, cooling coil valve V2, and dampers D2, 3, and 4 to hold plenum temperature on winter cycle.

T2 (outdoor) puts system on minimum outside air when outdoor temperature reaches 65 F, closes valves V1 and 4 and makes low limit thermostats inoperative.

T3 (return air) resets T4 in accordance with return air temperature on summer cycle.

T4 (plenum) controls V2 to hold design temperature off cooling coil during summer, is set for 60 F in winter.

T5 (plenum) controls V3 to hold air temperature off heating coil during winter cycle.

T6 (outdoor) resets T5 in accordance with winter or "between seasons" outside temperature.

T7 (zone) modulates hot and cold deck mixing dampers.

T8 (low limit) stops fans on winter cycle if supply air temperature falls below preset point.

T9 (master outdoor) resets all zone thermostats on summer cycle.

Humidistat action:

H1 (return air) control steam valve V4 to humidifier.

H2 (zone) acts on valve V2 to refrigerate cooling coil for dehumidification.

Valve action:

V1 (preheater steam) is normally open.

V2 (cooling coil) is three-way, normally open.

V3 (hot deck) is normally open.

V4 (humidifier steam) is normally closed.

from the heating coil, and is controlled by the humidistat at its winter setting. When clean, odorless steam is available, this kind of humidifier is considered superior to water sprays or pans. Besides, the steam unit does not tend to increase the sensible heat of the air stream to any extent.

Compensation for Seasonal Changes

The changeover from winter to summer operation is usually made through a manually operated summer-winter switch on the systems we have described. When on winter setting, all heating equipment, the humidifier, and the low limit thermostats are functioning. On summer setting, the humidifier and low limit thermostats are secured, and the settings changed on the heating coil and space thermostats and on the return air and/or space humidistats. Automatic operation can of course be designed into the system to effect these changes, and in addition, space thermostats may be reset automatically all during the summer in accordance with outdoor temperature, if desired.

How Dampers Function

Let us look at the main damper operation for a moment. When the fans are started automatically, the minimum outside air damper (two position) opens wide, and control of the maximum outside, return, and exhaust air dampers (modulating) is by a plenum thermostat.

In Fig. 1, there is no preheat coil, and as outdoor temperature rises, the thermostat acts to open the outside and exhaust air dampers and to close the return. Thus a constant plenum temperature is maintained at all times. When the outside temperature reaches, say, 60 F, the maximum outside air damper opens wide and the system functions on 100 percent outside air. This continues until the summer design temperature is reached, at which point the damper reverses and the system operates on minimum outside air.

Sizing the Hot & Cold Decks

It is well to remember that the cold deck, containing no equipment, has a much lower air flow loss than does the hot deck with its coils. Air velocity in the cold deck might be 800 to 1200 fpm, depending on conditions. The hot deck coils in the same system may be sized for 500 to 800 fpm, and this deck may match the required coil size or be tapered on both sides of the coil.

At peak winter load, the hot deck will be delivering air at, say, 110 F, while some zones may require air for mixing at 85 F. If cold deck temperature in winter is set at 60 F, then a certain volume of hot deck air at 110 F must be mixed with a certain volume of cold deck air at 60 F to attain the mixture temperature of 85 F. The following equation can be used to calculate the necessary hot and cold air quantities:

$$\text{Percent cold deck air} = \frac{(\text{Hot deck temp., F} - \text{Mixture temp., F})}{(\text{Hot deck temp., F} - \text{Cold deck temp. F})}$$
$$= (110 - 85)/(110 - 60)$$
$$= 0.50 \text{ or } 50 \text{ percent}$$

Thus, the mixture would contain 50 percent air from the cold deck, and consequently 50 percent hot deck air.

During the summer, the cooling coil may be delivering air at about 58 F (when it is operating for dehumidification) while some zones require air at 65 F.

If hot deck air is held at 80 F, to calculate the hot-cold air proportions:

$$\text{Percent cold deck air} = (80 - 65)/(80 - 58)$$
$$= 0.68 \text{ or } 68 \text{ percent}$$

How Mixing Is Effected

Zone space thermostats control the pair of zone mixing dampers (one for hot air and the other for cold) at the plenum outlet. Winter space setting usually varies from 72 to 75 F in areas having cold weather. The mixing dampers should be of the opposed blade type to afford a smooth control. When there are a number of zones on one plenum, balancing these dampers may take some time, and only trained personnel should be used for this work.

A low limit thermostat is placed in each zone duct downstream from the outlet to reflect the mixed air temperature. These should be set at about 5 F below design space temperature, and will act to stop the fan when temperature reaches the low point.

Freeze-Up Protection

A comprehensive investigation of coil freeze-up problems and solutions has been presented in a recent HPAC Engineering Data File and in a subsequent article on the same subject[2]. There are, however, several points which bear stressing as regards the central plenum.

When a single row preheat coil is placed in the mixed return-outdoor air stream, a danger of inadequate air mixing exists. A stratum of below freezing air impinging on a steam coil which operates from a modulating valve can cause any water which collects at the return end of the coil to freeze in a very short time. A dual valve arrangement such as described earlier can solve this problem if one valve is kept open at all times. There will always be some leakage through dampers, and keeping a definite steam pressure in the coil during "off" periods may prevent a costly freeze-up.

Be Careful With Steam

Steam coils in general require the use of extra means to avoid freeze-up. Tight closing dampers and perhaps an air bypass around the coil help, especially in conjunction with continuous coil steaming.

Hot Water Adds Safety

A hot water coil, if it drains well, is not nearly so susceptible to freeze-up as one using steam. If the full volume of water is passed through the coil at all times (at varying water temperature) the danger is almost eliminated. An individual pump is required for each coil to do this, and therefore the system will be more expensive, but the result obtained is worth it. Another advantage is that the internal film heat transfer in the coil tubes is enhanced with a good-velocity steady flow.

The freeze-up danger is not often easily avoided, and the reader is urged to take careful cognizance of the effect which damper operation, coil location, valving, and the heat transfer medium used will have toward increasing or decreasing that danger. ∓

[2] *How to Provide Freeze-Up Protection for Heating and Cooling Coils*, HPAC Engineering Data File, July, 1961; and *More on How to Provide Freeze-Up Protection for Heating and Cooling Coils*, September, 1961

Selecting centrifugal pumps —

Net Positive Suction Head

— what it is
— what it means
— how to include it in your calculations

By HAROLD W. WOODHOUSE
Assistant Professor
Mechanical Engineering Department
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This article treats, from start to finish and in detail, the subject of Net Positive Suction Head in reference to selecting centrifugal pumps. It is therefore valuable by itself as a comprehensive discussion of this important variable; especially so since it includes a number of practical examples to illustrate definitions and necessary calculations.

This is also the final article in a series of three (see October and November issues) dealing with the many things which the engineer must consider in order to be certain that the right pump is selected for the job at hand.

A SET of performance curves for a centrifugal pump may or may not include a curve of net positive suction head. Sometimes it is vital that the *available* NPSH be known so that we can be sure it is greater than the NPSH required by the pump.

What is net positive suction head? The total suction head (in ft of liquid absolute) determined at the suction nozzle and corrected to datum (pump centerline) less the vapor pressure of the liquid (in ft absolute).

There are various objections to the use of NPSH; one being that it creates the impression that the pump sucks the liquid whereas it is actually pushed into the pump by the action of atmospheric pressure plus or minus a static head or lift in an open cycle, or by the static head only if suction is from a closed vessel with the liquid at its boiling point.

Except in this last instance, NPSH does not equal static head or lift, but in that instance (closed vessel, boiling liquid) all the NPSH available is the height of the liquid level above the pump centerline (ft) minus all the piping losses in the suction side.

In Fig. 1, there is a static head of 6 ft on the suction side of the pump. The NPSH available at the pump flange might be, say, 35 ft or 2 ft, depending on the liquid, its temperature, altitude, whether the tank is closed or open, and on the pipe friction between tank and pump.

The 6 ft static head might be eliminated by the friction in the suction piping and fittings, so that the pump might have to operate as if with a suction lift. It depends — the pump might be next to the tank or 1000 ft away.

In Fig. 2, there is a theoretical 6 ft lift on the suction side. The NPSH available at the pump might be, say, 23 ft, or zero. The actual lift on the pump might not be much more than 6 ft — or it could be 25 ft or more, depending again on pipe friction.

NPSH Available *vs* Required

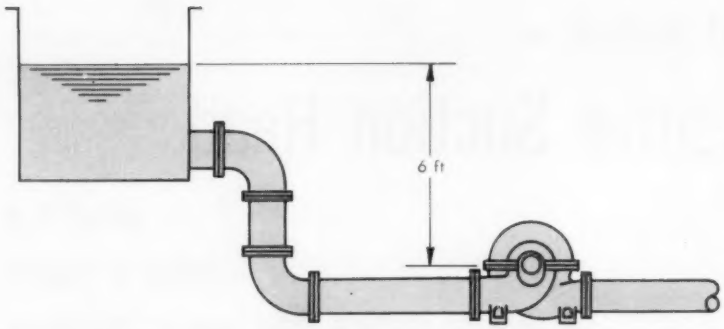
A clear distinction should be made between NPSH *available* and NPSH *required*.

The available NPSH refers to that excess of pressure of the liquid over its vapor pressure at the exact condition of the liquid as it arrives at the pump suction flange. Note, however, that head conditions have as a reference point the pump centerline. This means that all influences having any effect on the condition of the liquid on its journey from source to pump must be considered. The exact composition of the liquid and its temperature must be known to determine its vapor pressure. Again, for open cycle operations, altitude of the pump must be known since atmospheric pressure will decrease with an increase in altitude.

Every pump operating at a particular speed and capacity requires a certain minimum NPSH for satisfactory operation. This "need" is called the *required* NPSH. It represents the head loss which occurs in transporting the liquid from the suction flange to the point of minimum head just inside the impeller vanes.

If the available NPSH does not exceed the required NPSH, then cavitation will occur. Actually, to allow for discrepancies in estimating the available NPSH there should be a slight safety margin allowed.

Graphic illustrations of NPSH and the determining



1 HIGH TANK location relative to pump centerline results in "static head" condition, excluding pipe resistance. NPSH will then exist in accordance with Fig. 3, opposite

factors for the two tank/pump relationships are shown in Figs. 3 and 4.

If cavitation does occur, it can vary all the way from being barely discernible to being detrimental to the life of the impeller and/or shaft.

In passing, it might be mentioned that some condensate pumps operating in a closed cycle where the available NPSH is only 1 or 2 ft are often cavitating without noticeably detrimental effect, but that these pumps are of a special design.

Apparently, the seriousness of the cavitational effect is roughly tied to the quantity of liquid being handled, so that cavitation forces in a condensate pump of small flow are insufficient to develop offensive symptoms.

Barometric, Vapor Pressures

Looking ahead for a moment, note that Fig. 5 is a graphic presentation of the effect of altitude on atmospheric pressure, and that Fig. 6 gives water vapor pressure as a function of water temperature. Both of these direct-reading charts will be useful in calculating NPSH, as shown in the following, and in the examples to come.

It is well known that standard sea level barometric pressure equals 29.92 in. Hg. This is the height of a column of mercury which the pressure of the atmosphere will support. This value also can be expressed as 14.7 psi.

The height of a column of liquid which this atmospheric pressure will support is such that, according to its specific gravity, it will exert a downward force of 14.7 psi to balance the force exerted by the atmosphere.

For water, since 1 in. Hg equals 1.134 in. WG and 1 psi equals 2.306 ft WG, we have

$$1.34\ (29.92) = 14.7\ (2.306) = 33.9 \text{ ft. WG}$$

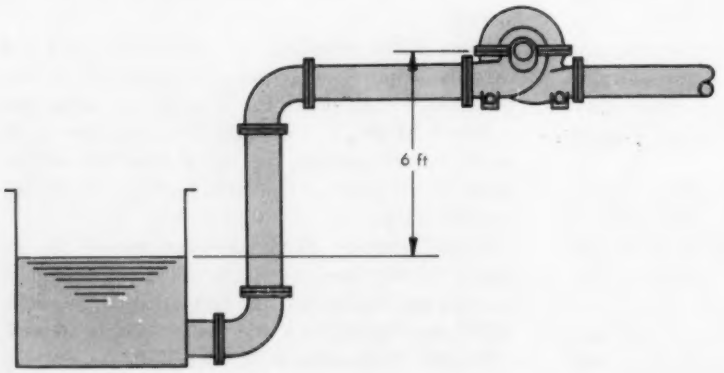
So, for normal cool water of specific gravity 1.0 at sea level there is a total pressure equivalent, H_a of 33.9 ft of head available at the surface of the water. H_a, then, can be defined in general terms as the absolute pressure on the surface of the liquid from which the pump is taking its suction, expressed in ft of the liquid.

H_a will decrease with altitude, and this reduction may be of considerable importance in some installations. Here, then, the usefulness of Fig. 5 becomes apparent.

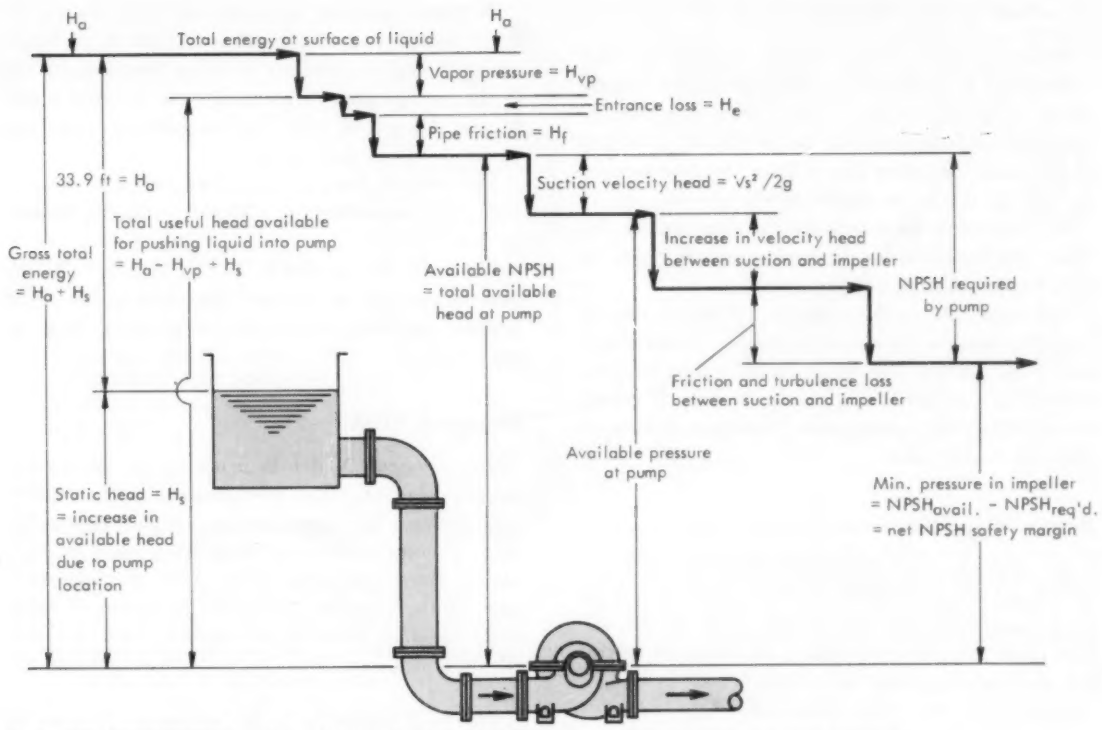
To H_a must be added the static head, H_s (Fig. 3) or the static lift, H_l (Fig. 4) must be deducted from it to obtain the gross available total energy on the suction side.

Of this, a small amount of the energy is vapor pressure, H_{vp}, which must be deducted from the gross total to obtain the useful available head. For cool water at sea level this value would equal about 1 ft.

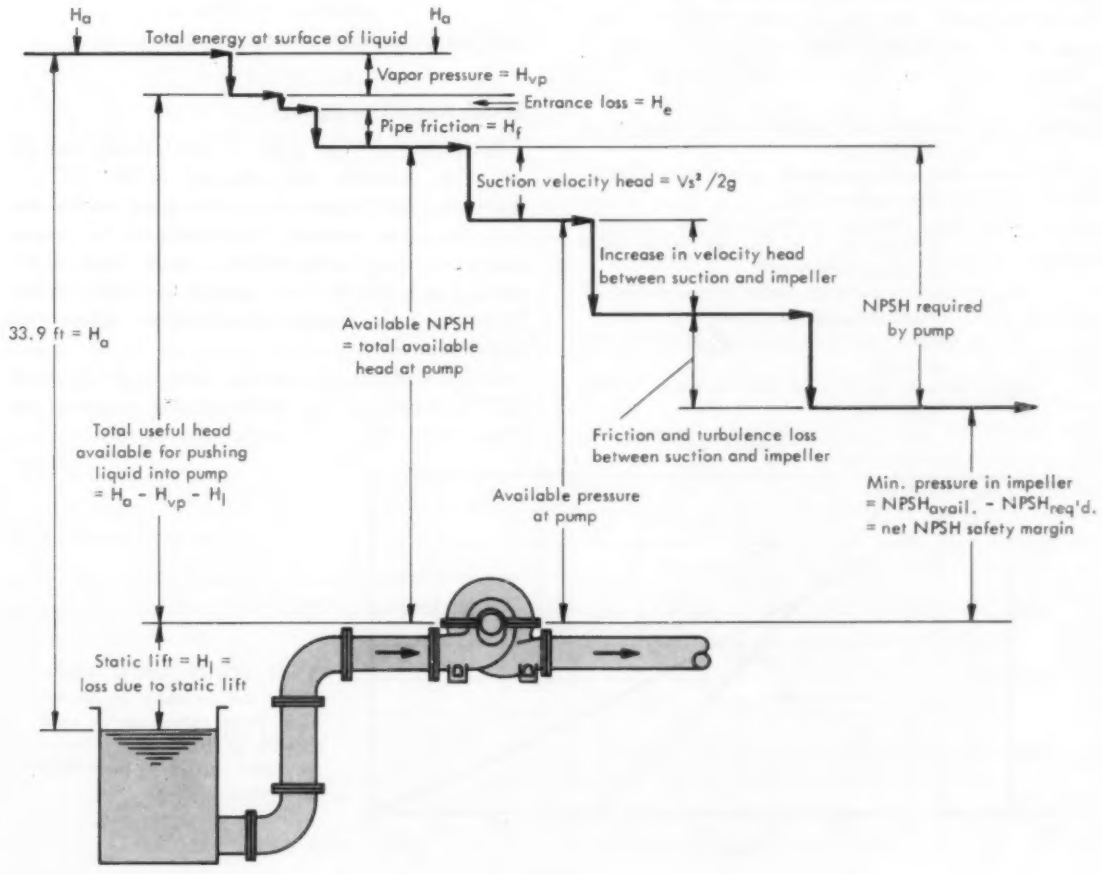
Fig. 6, which expresses vapor pressure as a function of water temperature, is therefore useful in providing this additional qualification.



2 LOW TANK relative to pump centerline means "lift" situation, disregarding system resistance. Fig. 4, opposite, shows NPSH factor relationships for this arrangement


H_a
Total energy at surface of liquid
H_a
Vapor pressure = H_{vp}
Entrance loss = H_e
Pipe friction = H_f
33.9 ft = H_a
Suction velocity head = $Vs^2/2g$
Total useful head available for pushing liquid into pump = $H_a - H_{vp} + H_s$
Increase in velocity head between suction and impeller
Gross total energy = $H_a + H_s$
Available NPSH = total available head at pump
NPSH required by pump
Friction and turbulence loss between suction and impeller
Available pressure at pump
Min. pressure in impeller = $NPSH_{avail.} - NPSH_{req'd.}$ = net NPSH safety margin
Static head = H_s = increase in available head due to pump location

3-4 RELATIONSHIPS bearing on determination of NPSH for two basic pump/source arrangements


H_a
Total energy at surface of liquid
H_a
Vapor pressure = H_{vp}
Entrance loss = H_e
Pipe friction = H_f
Suction velocity head = $Vs^2/2g$
Increase in velocity head between suction and impeller
NPSH required by pump
33.9 ft = H_a
Available NPSH = total available head at pump
Total useful head available for pushing liquid into pump = $H_a - H_{vp} - H_l$
Friction and turbulence loss between suction and impeller
Available pressure at pump
Min. pressure in impeller = $NPSH_{avail.} - NPSH_{req'd.}$ = net NPSH safety margin
Static lift = H_l = loss due to static lift

Two Subtractions Remain

Referring again to Fig. 3, we see that the total useful head available for pushing the liquid into the pump equals $H_a \div H_s - H_{vp}$. From this must be deducted the losses incurred by the liquid on its way to the pump, and after this is done, the final remainder will be the net available NPSH.

The first loss to be deducted is the entrance loss, H_e, where the liquid enters the system piping. Next, the pipe friction, H_f must be subtracted.

The remainder is the available NPSH — the net available head in excess of the vapor pressure and minus the suction line losses at the pump suction, referred to the datum of pump centerline. It should be noted that the velocity heat at suction, $V_s^2/2g$, is included in this value.

Restate Equation

Referring to Fig. 3, which shows the available NPSH, the required NPSH, and the pressure margin for a pump operating with a static head on the suction (flow from an open tank), we see more clearly that the preceding may be written

$$NPSH_{avail} = (H_a - H_{vp}) + H_s - H_e - H_f$$

If a gage is installed at the pump suction flange so that the gage elevation corresponds to the centerline of the pump, then the available NPSH as measured on an actual installation is

$$NPSH_{avail} = 2.31(P_a + P_s - P_{vp})/W_g + V_s^2/g$$

where

$NPSH_{avail}$ = available net positive suction head, ft of liquid

P_a = absolute atmospheric pressure at installation elevation, psi

P_s = gage pressure at suction flange of pump, corrected to centerline, psi (minus value if reading is vacuum)

P_{vp} = vapor pressure of liquid at temperature of liquid at suction flange, psi

W_g = specific gravity of liquid at operating temperature

V_s = velocity of flow at and in pump suction flange, fps

Not only must the pump suction gage reading be corrected to centerline conditions (add ft in height above centerline, subtract if below center line) but if the suction gage is situated some distance ahead of the flange the pipe friction between gage and pump should be subtracted.

The velocity head is that which exists at the suction gage connection; it will vary with the amount of flow.

Similarly, the available NPSH, required NPSH, and the pressure margin are illustrated in Fig. 4 for a pump operating with a lift, with suction from an open tank.

Required NPSH

The *required* NPSH is made up of the suction velocity head ($V_s^2/2g$) plus the increase in velocity head between the pump suction flange and impeller vanes plus the friction and turbulence losses between suction flange and some point inside the inlet vane edge of the impeller, where the condition of minimum absolute pressure is reached. This required NPSH is determined by test of individual pump designs.

The final remainder is the minimum pressure in impeller over vapor pressure:

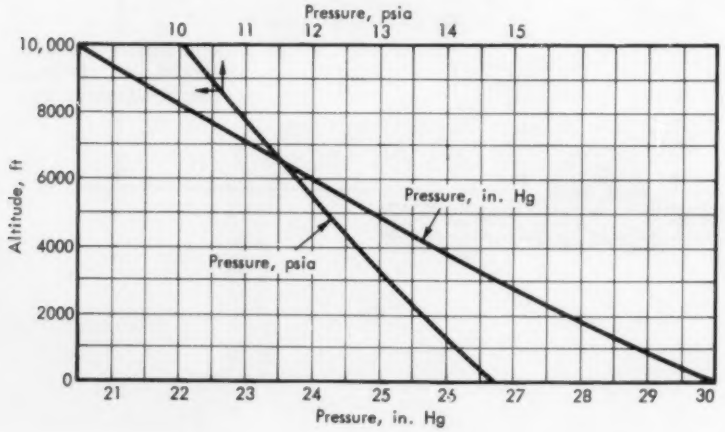
$$NPSH_{avail} - NPSH_{req'd}$$

and equals the safety margin available.

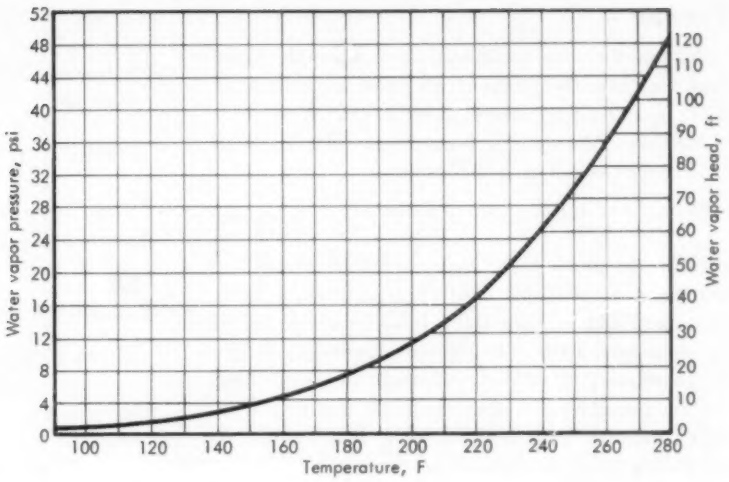
Head May "Disappear"

Inspection of Figs. 3 and 4 will indicate that the excess of available over required NPSH will normally be greater when there exists head on the suction side rather than lift. It is not quite so obvious that it may be possible to have a static head on the suction and yet not have enough available NPSH. There are two common circumstances where this might occur.

In one instance, the suction head might be small and the length of the suction piping so great that



5 ALTITUDE effects atmospheric air pressure as shown here. These values can be used directly as H_a, energy exerted on liquid surface to push fluid into pump



6 VAPOR pressure, H_{vp}, expressed as function of water temperature here, is included as part of lift or head which must be subtracted from or added to total pressure

pipe friction more than eliminates the effect of having any static head, so that, in Fig. 3

$$NPSH_{avail} - NPSH_{req'd} = 0 \text{ (or minus value)}$$

The other situation may arise when the pump is connected on the suction side to a closed vessel in which the liquid is at its boiling point. This situation is illustrated in Fig. 7. Here, the absolute pressure H_a on the surface of the liquid becomes the same as the vapor pressure H_{vp} of the liquid, and H_a—H_{vp} equals zero.

Therefore in the equation for available NPSH

$$NPSH_{avail} = (H_a - H_{vp}) + H_s - H_e - H_f$$

the first term is zero, so that for a closed vessel with the liquid at or near the boiling point we may write

$$NPSH_{avail} = H_s - (H_f + H_e)$$

which is to say that the available NPSH equals the static head minus the piping losses.

This shows that where the pump suction is from a closed vessel, with liquid at its boiling point, the only available NPSH is the static head of the liquid surface above the pump centerline, minus all the piping losses, and so, in some installations the margin between available NPSH and required NPSH may be zero or even a negative value. This spells trouble.

In a Closed System —

Consider an installation where pressures can be measured — a closed system with liquid at its boiling point. If, in Fig. 7, the gage vapor pressure on top of the tank is P_t, then the absolute pressure is

$$P_{vp} = P_a + P_t$$

and if we substitute this for P_{vp} in the equation for available NPSH:

$$NPSH_{avail} = 2.31/W_g[P_a + P_s - (P_a + P_t)] + V_s^2/2_g$$
$$= 2.31/W_g[P_s - P_t] + V_s^2/2g$$

This is to say that the measured available NPSH in a closed system equals the difference between the gage reading at the pump suction and the gage reading at the top of the vapor tank, corrected to ft of head for the liquid at its actual temperature plus the suction velocity head.

Examples in Calculating NPSH

Example 1

Assume a pump handling 500 gpm of water at 173 F from an open tank. The liquid level is 9.7 ft above the pump centerline. Installation is to be made at sea level, and the proposed pump has a required NPSH of 12 ft at the specified flow.

Solution: First, the piping entrance and friction losses must be determined. These will depend on the volume flow, stated as 500 gpm, and on the size and length of pipe, number of fittings, and valves. Such information is available in hydraulic handbooks, and must be included for a proper determination. Assume in this instance that the loss is equal to 3.6 ft of head. Also:

P_a = standard sea level atmospheric pressure
= 14.7 psia
P_{vp} = vapor pressure 6.417 psia for 173 F (from steam tables or Fig. 6)
W_g = specific gravity of water at 173 F
= 0.973 (from steam tables)

Therefore:

$$NPSH_{avail} = 2.31/0.973 \times (14.7 - 6.417) + 9.7 - 3.6$$
$$= 25.75 \text{ ft}$$

Since the required NPSH is 12 ft, there is an ample margin over this required value.

Example 2

Assume the same conditions as in Example 1, except that now the pump is raised to an altitude of 7000 ft, and piping losses equal 11.6 ft.

Solution: Atmospheric pressure at 7000 ft equals 11.38 psia (from Fig. 5). Therefore:

$$NPSH_{avail} = (11.38 - 6.417)(2.31/0.973) + 9.7 - 11.6 = 9.9 \text{ ft}$$

Since the pump has a required NPSH of 12 ft, a deficiency of available head exists, and some modification should be made to bring the available NPSH up to at least 13 ft. The solution, depending on the circumstances, might be to increase the static head on the pump by elevating the tank another 3.4 ft, or by increasing the liquid level by that amount, or by reducing the temperature of the water.

Sometimes, where it is not feasible to make such changes, a pump can be obtained which requires less NPSH. Sometimes a reduction of NPSH can be obtained by using a different impeller design in the same pump, but often a larger pump with lower flow velocities is required.

Example 3

A pump is to move water at 135 F from an open reservoir. The pump is installed at sea level, and the water surface is 8 ft below the pump centerline. Piping friction losses equal 8.9 ft.

Solution:

$$NPSH_{avail} = (14.7 - 2.537)(2.31/0.985) + (-8) - 8.9 = 11.6 \text{ ft}$$

Here again, if the required pump NPSH is 12 ft, there is a slight deficiency which should be rectified.

Example 4

A sea level pump is to handle 280 F water at 50 psig at the suction flange. Velocity in the suction pipe is to be 13.6 fps.

Solution:

$$\text{Velocity head} = 13.6^2/2g = 2.8 \text{ ft}$$

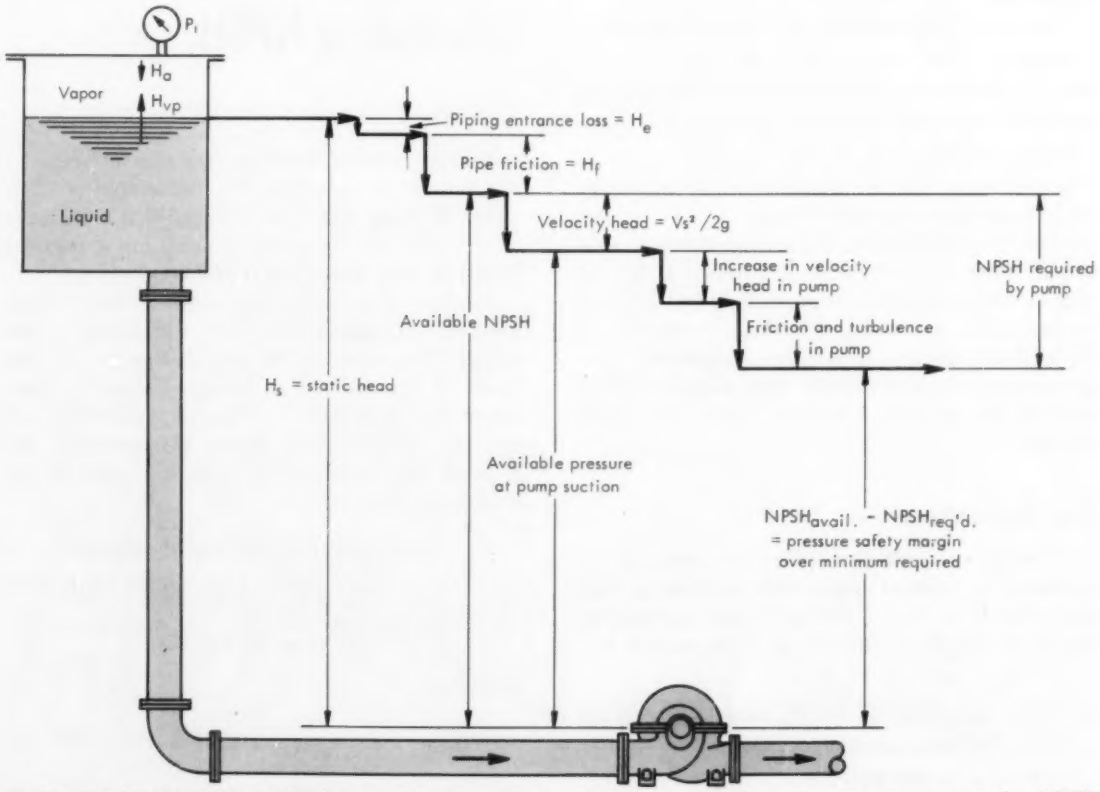
$$\text{Vapor pressure (280 F)} = 49.20 \text{ psia}$$

$$\text{or} \quad 49.20(2.31/0.93) = 122.1 \text{ ft}$$

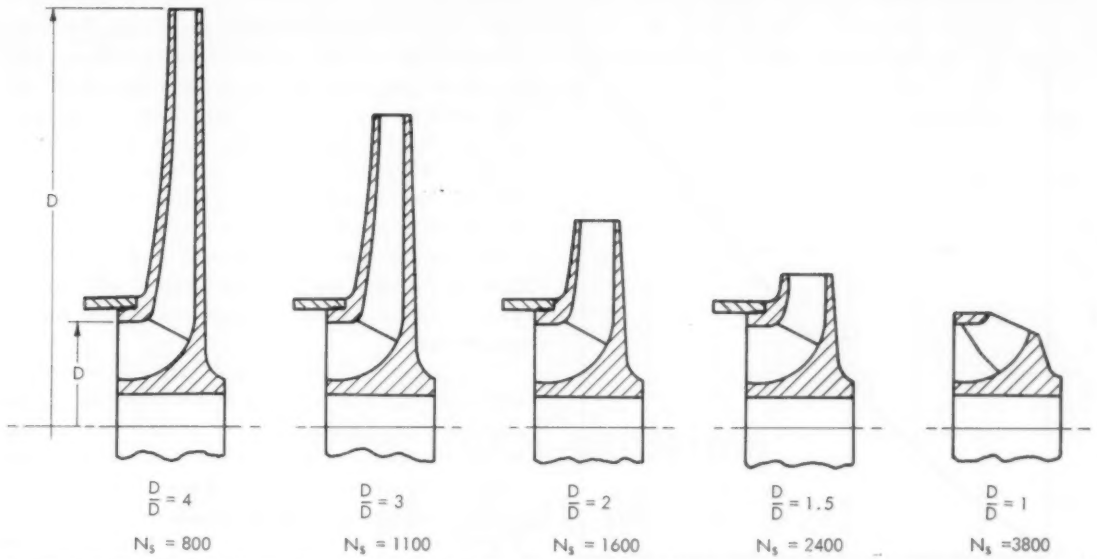
$$\text{Total suction head} = (50.0 + 14.7)(2.31/0.93) + 2.8 = 163.5 \text{ ft}$$

$$NPSH_{avail} = 163.5 - 122.1 = 41.4 \text{ ft}$$

While this might seem ample, it should be kept in mind that a correction factor for high temperature will have to be applied to the required pump NPSH, and another correction for possible variations in boiler feed water temperature, so that the required



7 CLOSED TANK with liquid at boiling point means absolute pressure on liquid equals vapor pressure, so that NPSH equals merely static head minus the piping losses



8 FIVE IMPELLERS of increasing specific speed. Ratio of impeller outside diameter to inlet eye diameter (D_2/D_1) decreases with increase in specific speed

NPSH may show a considerable increase over cold water calculations.

Example 5

Water at the boiling point must be pumped from a closed vessel at 165 psig. The liquid level in the vessel is controlled by a high-low device. Maximum level of liquid above the pump centerline is 8 ft, and minimum level 6.5 ft. The pump will operate at sea level, and the pipe friction losses equal 1.5 ft.

Solution: The obvious thing to do is to use the minimum liquid level. This is an installation similar to that illustrated in Fig. 7, where $P_l = 165$, and where $H_a = H_{vp}$. Therefore

$$NPSH_{avail} = H_s - (H_f + H_e)$$
$$= 6.5 - 1.5 = 5.0 \text{ ft}$$

Example 6

We are to pump 100 F butane from a closed vessel under pressure. The pressure in the vessel will be the vapor pressure of butane corresponding to 100 F, or 51.6 psia. The liquid level in the vessel is 8 ft above the pump centerline, and pipe friction losses equal 2.4 ft.

Solution:

$$NPSH_{avail} = 8 - 2.4 = 5.6 \text{ ft}$$

NPSH and Hydrocarbons

In connection with the pumping of hydrocarbons, it has been found that somewhat smaller required NPSH may be tolerated than if the pump were operating on water. The general feeling is that this is because most hydrocarbons are composed of elements having different vaporizing points, and that this softens the effect of a developing cavitation condition. For this reason, some pumps on critical hydrocarbon applications are operated with a smaller NPSH than would be used for water.

The Standards of the Hydraulic Institute include a chart giving the correction factors for non-viscous hydrocarbons. From this chart, the percentage of NPSH required relative to water requirements can be determined, when the specific gravity and vapor pressure of the hydrocarbon is known.

NPSH and Suction Lift

Obviously there must be a connection between NPSH and maximum permissible suction lift, since both relate to suction conditions. The equation for available NPSH may be rewritten as

$$(H_f + H_e) - H_s = (H_a - H_{vp}) - NPSH_{req'd}$$

but

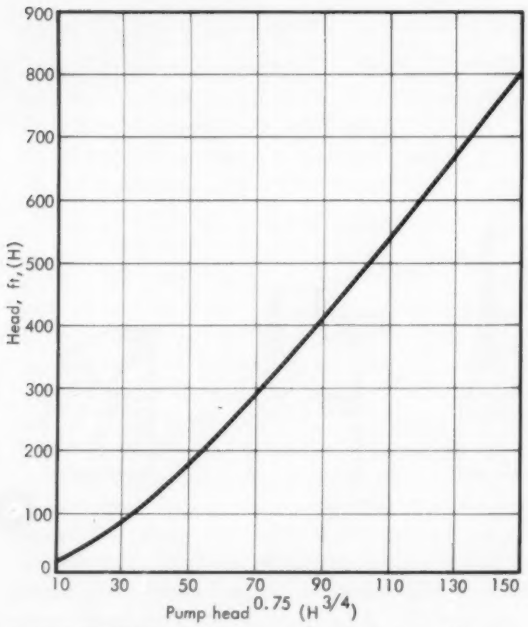
$(H_f + H_e) - H_s$ = total maximum permissible suction lift

and therefore

Total maximum permissible suction lift = $(H_a - H_{vp}) - NPSH_{req'd}$

which in turn equals the absolute pressure on the liquid surface, minus the vapor pressure, minus the required NPSH.

It should be noted that where a static lift exists on the suction side of the installation, we must substitute a $+H_l$ for the $-H_s$ on the left hand side of the equation just discussed. In effect, with a fixed maximum permissible suction lift a static head on the suction allows the presence of more piping friction losses in the suction line, whereas a static lift will put more restriction on the allowable suction



9 PUMP HEAD to ¾ power can be read from this curve for insertion in equation for specific speed

piping friction losses if the maximum total suction lift is not to be exceeded.

The Hydraulic Institute Standards include curves stating maximum practicable allowable suction lifts for single and double suction pumps operating at various specific speeds.

What Is Specific Speed?

Specific speed is defined as the speed at which a pump of a particular design would have to run to deliver 1 gpm against a head of 1 ft.

This is a guide to the type of pump impeller needed, and to the permissible operating lift. It is calculated from the following equation:

$$N_s = (\sqrt{gpm} \times rpm)/H^{3/4}$$

where

N_s = specific speed
H = head, ft per stage

With the specific speed known, the approximate proportions and type of impeller are indicated. Fig. 8 shows five impellers of increasing specific speed. Note the decreasing value of the ratio of the impeller outside diameter to the inlet eye diameter, D_2/D_1, with increasing specific speed.

At a specific speed of about 4000, the radial form of the impeller has virtually disappeared and a mixed flow has developed.

Specific Speed Is Guide

From an inspection of Fig. 8, it can be seen that a high head type will have a low specific speed, and a low head type a high specific speed. Now for maximum suction lift with suction liquid and vapor pressure fixed, the only variable is the required NPSH. The smaller the required NPSH, the greater the permissible suction lift. Specific speed is a reliable guide in determining the maximum permissible suction lift, which also means, therefore, that it serves as a guide to minimum required NPSH.

In terms of stated capacity and head, this means then that a low specific speed pump will operate with a greater suction lift than one with a higher specific speed.

If a pump (double or single suction) operating with a specified head, capacity, and specific speed, does not exceed the suction lift given by the curves in the Hydraulic Institute Standards there is not likely to be any cavitation trouble.

For convenience in calculating specific speed, Fig. 9 gives the values of $H^{3/4}$ for corresponding values of H.

Example 7

Assume a single suction pump and a suction lift of 12 ft, with a required head of 200 ft. The pump is motor driven at 3500 rpm. What will be the maximum capacity which can be handled without cavitation?

Solution: From the appropriate curve in the Hydraulic Institute Standards, we find that the maximum specific speed is 1625. Therefore

$$N_s = (\sqrt{gpm} \times rpm)/H^{3/4}$$
$$= (\sqrt{gpm} \times 3500)/200^{3/4}$$

and

$$Gpm = [(1625 \times 200^{3/4})/3500]^2$$
$$= 605 \text{ maximum}$$

Example 8

A double suction pump is to move 1000 gpm at 100 ft head, operating at 3500 rpm. What is the maximum permissible suction lift?

Solution:

$$N_s = (\sqrt{1000} \times 3500)/100^{3/4}$$
$$= 3480$$

From the Hydraulic Institute Standard curve for specific speeds of double suction pumps, we see that the maximum allowable lift is 11.5 ft.

Example 9

Pump and conditions are the same as in Example 8, except that pump speed is reduced to 1750 rpm.

Solution:

$$N_s = (\sqrt{1000} \times 1750)/100^{3/4}$$
$$= 1740$$

From the same curve the maximum lift can now be 26 ft. This points up the advantage of slower speed where lift is critical. ‡

Tables for Calculating Weights of Sheet Metal Ducts

By WILLIE HAMMER
Mechanical Engineer

THE TABLE on the following page will enable the engineer to read directly the weight, in lb per lineal ft, of galvanized ducts in sizes 12 in. by 86 in. up to 102 in. by 102 in.

Similar Tables published as the October and November 1961 HPAC Data Sheets gave weights for ducts in all smaller sizes down to 3 in. by 3 in.

The present Table (5) completes the series. This data has been tabulated for low pressure systems using galvanized iron in gages as recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers Guide.

Each weight Table is followed by a Table of conversion factors by which to multiply a given weight value when different gages of metal will be used, or for different materials (black iron or aluminum), either for medium or high pressure systems or when special rigidity is required.

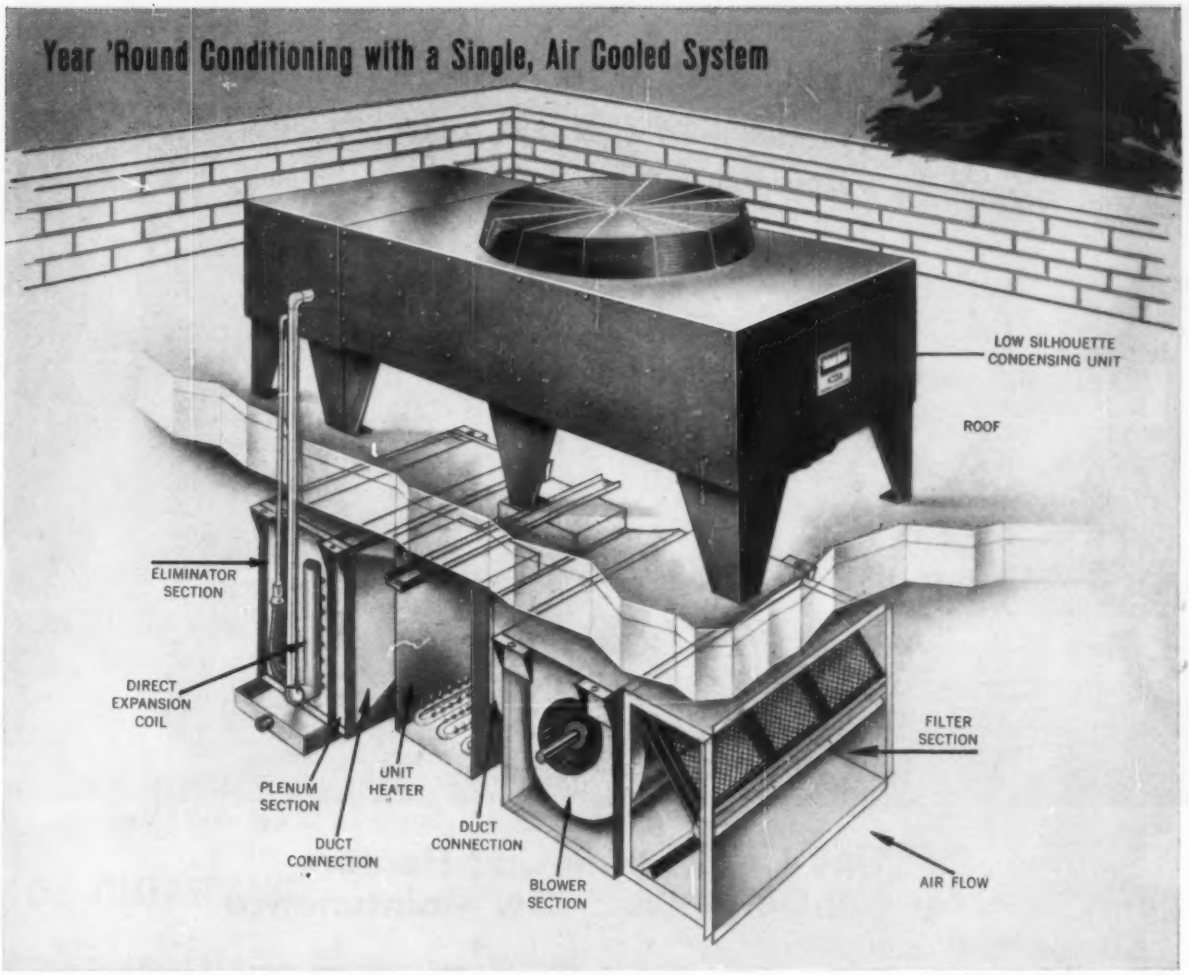
Note that an additional allowance of 15 percent should be added to the final calculated duct weight to cover seams, connectors, hangers, slips, scrap, and duct end closing pieces. Also, bracing and stiffening should be calculated separately and added to the duct weight total. ⫩

TABLE 5 — WEIGHTS OF RECTANGULAR GALVANIZED IRON DUCTS (lb per lineal ft) for duct sizes 12 in. by 86 in. to 102 by 102 in., 18 gage U.S. Std (2.156 lb per sq ft). Add 15 percent to given weights to cover seams, connectors, hangers, slips, scrap, and duct end closings. Bracing and stiffening should be calculated separately

Sides (in.)	86	88	90	92	94	96	98	100	102
12	35.2	35.9	36.6	37.4	38.1	38.8	39.5	40.2	41.0
13	35.6	36.3	37.0	37.7	38.4	39.2	39.9	40.6	41.3
14	35.9	36.6	37.4	38.1	38.8	39.5	40.2	41.0	41.7
15	36.3	37.0	37.7	38.4	39.2	39.9	40.6	41.3	42.0
16	36.6	37.4	38.1	38.8	39.5	40.2	41.0	41.7	42.4
18	37.4	38.1	38.8	39.5	40.2	41.0	41.7	42.4	43.1
20	38.1	38.8	39.5	40.2	41.0	41.7	42.4	43.1	43.8
22	38.8	39.5	40.2	41.0	41.7	42.4	43.1	43.8	44.6
24	39.5	40.2	41.0	41.7	42.4	43.1	43.8	44.6	45.3
26	40.2	41.0	41.7	42.4	43.1	43.8	44.6	45.3	46.0
28	41.0	41.7	42.4	43.1	43.8	44.6	45.3	46.0	46.7
30	41.7	42.4	43.1	43.8	44.6	45.3	46.0	46.7	47.4
32	42.4	43.1	43.8	44.6	45.3	46.0	46.7	47.4	48.1
34	43.1	43.8	44.6	45.3	46.0	46.7	47.4	48.1	48.9
36	43.8	44.6	45.3	46.0	46.7	47.4	48.1	48.9	49.6
38	44.6	45.3	46.0	46.7	47.4	48.1	48.9	49.6	50.3
40	45.3	46.0	46.7	47.4	48.1	48.9	49.6	50.3	51.0
42	46.0	46.7	47.4	48.1	48.9	49.6	50.3	51.0	51.7
44	46.7	47.4	48.1	48.9	49.6	50.3	51.0	51.7	52.5
46	47.4	48.1	48.9	49.6	50.3	51.0	51.7	52.5	53.2
48	48.1	48.9	49.6	50.3	51.0	51.7	52.5	53.2	53.9
50	48.9	49.6	50.3	51.0	51.7	52.5	53.2	53.9	54.6
52	49.6	50.3	51.0	51.7	52.5	53.2	53.9	54.6	55.3
54	50.3	51.0	51.7	52.5	53.2	53.9	54.6	55.3	56.1
56	51.0	51.7	52.5	53.2	53.9	54.6	55.3	56.1	56.8
58	51.7	52.5	53.2	53.9	54.6	55.3	56.1	56.8	57.5
60	52.5	53.2	53.9	54.6	55.3	56.1	56.8	57.5	58.2
62	53.2	53.9	54.6	55.3	56.1	56.8	57.5	58.2	58.9
64	53.9	54.6	55.3	56.1	56.8	57.5	58.2	58.9	59.6
66	54.6	55.3	56.1	56.8	57.5	58.2	58.9	59.6	60.4
68	55.3	56.1	56.8	57.5	58.2	58.9	59.6	60.4	61.1
70	56.1	56.8	57.5	58.2	58.9	59.6	60.4	61.1	61.8
72	56.8	57.5	58.2	58.9	59.6	60.4	61.1	61.8	62.5
74	57.5	58.2	58.9	59.6	60.4	61.1	61.8	62.5	63.2
76	58.2	58.9	59.6	60.4	61.1	61.8	62.5	63.2	64.0
78	58.9	59.6	60.4	61.1	61.8	62.5	63.2	64.0	64.7
80	59.6	60.4	61.1	61.8	62.5	63.2	64.0	64.7	65.4
82	60.4	61.1	61.8	62.5	63.2	64.0	64.7	65.4	66.1
84	61.1	61.8	62.5	63.2	64.0	64.7	65.4	66.1	66.8
86	61.8	62.5	63.2	64.0	64.7	65.4	66.1	66.8	67.5
88	62.5	63.2	64.0	64.7	65.4	66.1	66.8	67.5	68.3
90	63.2	64.0	64.7	65.4	66.1	66.8	67.5	68.3	69.0
92	64.0	64.7	65.4	66.1	66.8	67.5	68.3	69.0	69.7
94	64.7	65.4	66.1	66.8	67.5	68.3	69.0	69.7	70.4
96	65.4	66.1	66.8	67.5	68.3	69.0	69.7	70.4	71.1
98	66.1	66.8	67.5	68.3	69.0	69.7	70.4	71.1	71.9
100	66.8	67.5	68.3	69.0	69.7	70.4	71.1	71.9	72.6
102	67.5	68.3	69.0	69.7	70.4	71.1	71.9	72.6	73.3

CONVERSION FACTORS (gages for iron are U.S. Std; for aluminum, Browne & Sharpe)

For	Material	Gage	Lb per sq ft	Factor
Low pressure (to 1-½ in. WG)	Black iron	18	2.000	0.928
	Aluminum	16	0.720	0.334
Medium pressure (1-½ to 4 in. WG)	Galvanized iron	16	2.656	1.232
	Black iron	16	2.500	1.160
Or for special stiffness or rigidity	Aluminum	14	0.903	0.419
High pressure (4 to 8 in. WG)	Galvanized iron	14	3.281	1.522
	Black iron	14	3.125	1.449



. . . THE "ALL-SEASONS" SYSTEM BY DUNHAM-BUSH

Both heating and cooling are provided by the sensibly-engineered, economical Dunham-Bush "ALL-SEASONS" System. And the system's flexibility permits its use in a wide range of buildings—shopping centers, medical clinics, bowling alleys and many other single story structures.

Important space savings are made possible in two ways: low side equipment is suspended from the ceiling (conserving floor space); high side components may be installed on the roof or in a room remote from the conditioned area. Through the use of duct work it is possible to condition partitioned areas or separate rooms.

Major components of the system—'HAH' air handler and 'LSCU' condensing unit—are tested, proved Dunham-Bush products . . . in combinations carefully engineered and matched for maximum performance and economical operation.

Features of the system include:

- Packaged components eliminate expensive field installation costs.
- Central control station provides for remote operation.
- Pilot lights for visual check on performance.
- A.G.A. approved gas fired, warm air heating system. No gas lines in the conditioned area.
- Final piping connections can be made outside the conditioned area.

"ALL-SEASONS" systems are available in 16 different matched combinations. Range: 15 to 30 Tons cooling; 175,000 to 450,000 BTU/hr. heating.

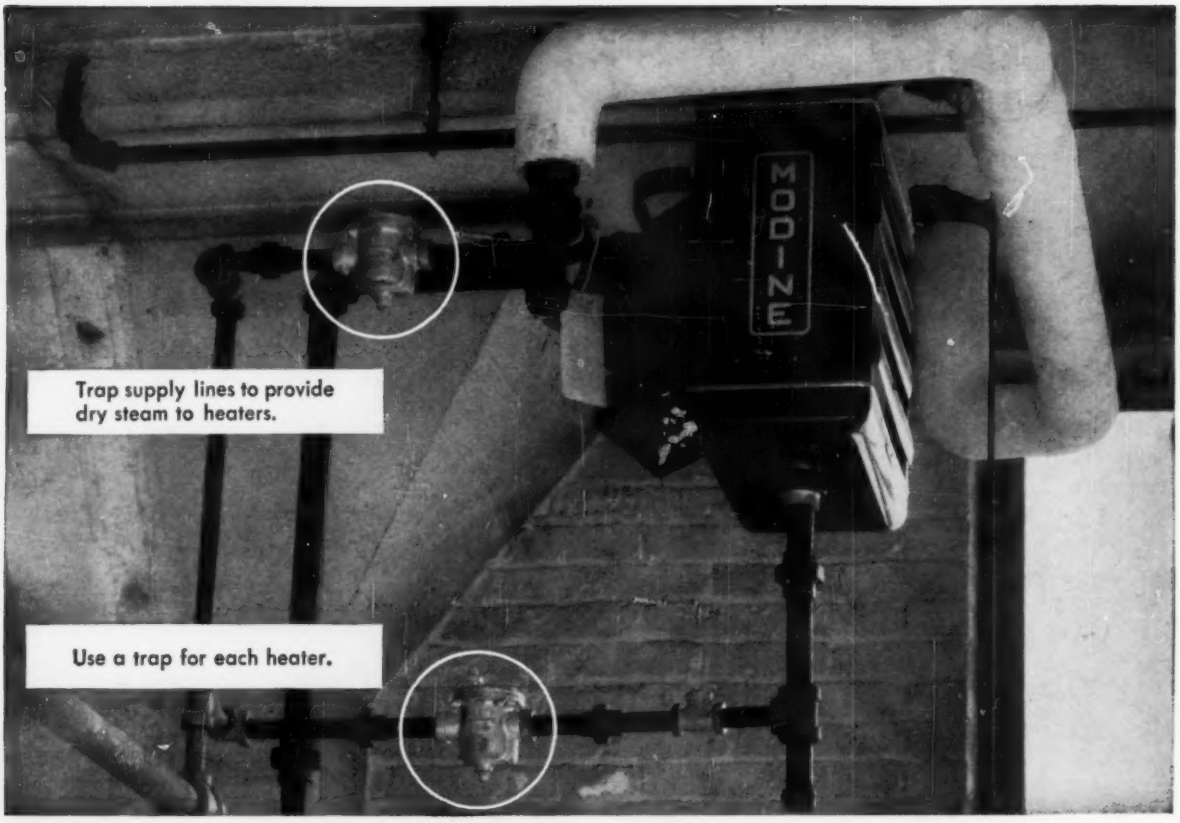
Request Form No. 6025.

DUNHAM-BUSH

DUNHAM-BUSH, INC.

WEST HARTFORD 10, CONNECTICUT, U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES



Tips on Trapping Unit Heaters for Full Output and Low Maintenance

• If unit heaters are clean and the steam supply and return lines are adequate, their performance will depend entirely upon the steam trapping. Here are some trapping pointers to insure plenty of heat when it is needed:

1. Trap supply lines to take care of condensate formed by radiation loss.

2. Use one trap for each heater. Two or more heaters drained by a single trap will fail to deliver maximum btu output.

3. Size traps properly. Many a unit heater is handicapped by a trap lacking adequate condensate and *air* handling capacity. The few dollars extra for larger traps insure fast heatup, full output and freedom from coil corrosion.

4. Install traps correctly. Put trap below and close to heater. Install a bypass around the trap if the heater must be kept in operation at all times. A shut-off valve in the discharge line facilitates trap inspection. Use of check valves and strainers is dependent upon piping conditions and the traps used.

5. Protect against PRV failure where freezing could occur. Sometimes heaters supplied with reduced pressure steam are installed where freezing could occur if traps failed to open. In this case select traps that will open at maximum steam supply pressure and still have adequate capacity at reduced pressure.

FREE ON REQUEST—COMPLETE INFORMATION on the above points, diagrams, selection data, tables and additional recommendations are contained in Armstrong Bulletin No. 252. Also includes BTU output ratings for all models of 30 makes of unit heaters. Call your local Armstrong Factory Representative or write direct.

860 Series for low pressure heating service.

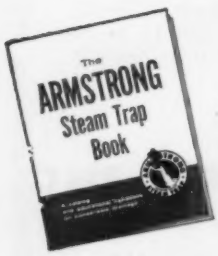
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

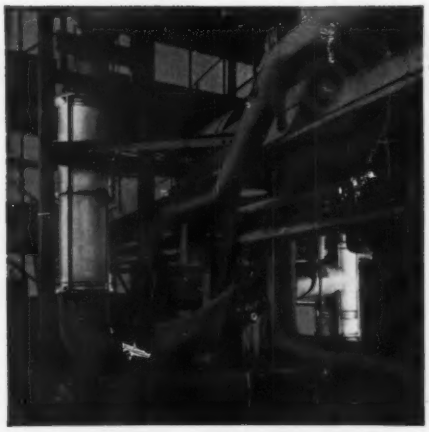


The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

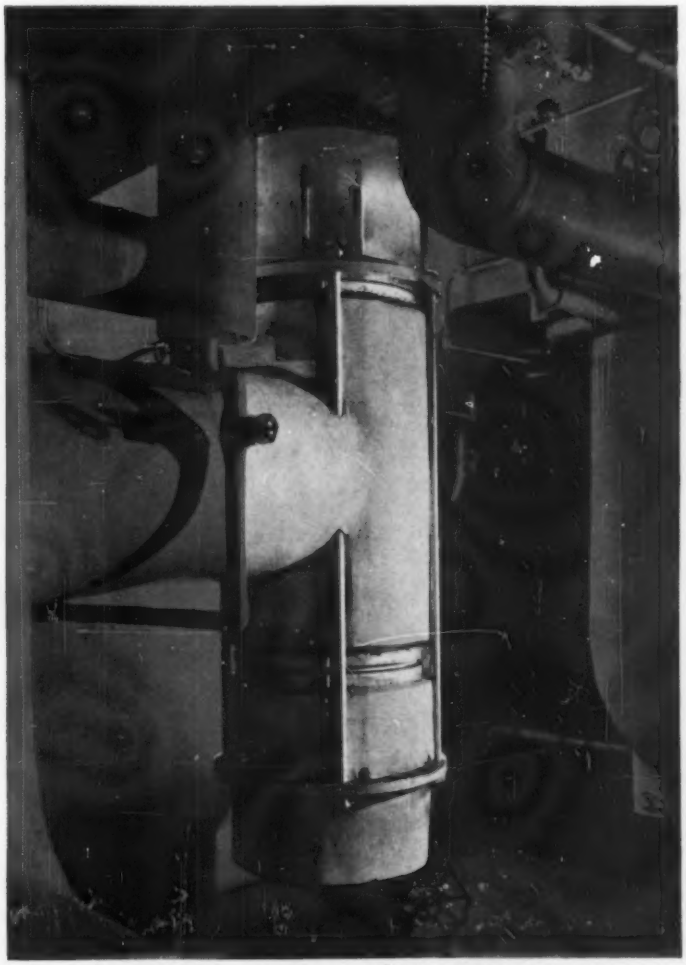
ARMSTRONG MACHINE WORKS

8746 Maple Street, Three Rivers, Michigan

"See Our Catalog in Sweet's Industrial Construction File"



In the foreground, a 20" ZALLEA Universal Expansion Joint absorbing lateral movement.



At a major Eastern oil refinery, a 20" Zallea Pressure Balanced Expansion Joint installed on a steam turbine exhaust nozzle.

it's ZALLEA for maximum reliability... the tough jobs show why

Six tough Zallea Expansion Joints protect three 10,000 kw turbine generators from the wallop of thermal stresses . . . real hot-spot duty. Each generating unit has a 20" pressure balanced, self equalizing expansion joint installed at the turbine exhaust nozzle to absorb reaction load due to internal pressure acting against the turbine casing. A 20" universal expansion joint absorbs lateral deflection in the pipe run from the pressure balanced unit. Temperatures range from 0° to 615° at start-up, back to 475° in operation, at 200 psig. To cope with these cycles, the turbines demand—and get—the maximum reliability of Zallea Expansion Joints.

Whatever the service, none of the many factors affecting Zallea Expansion Joint reliability are left to guesswork. Zallea Expansion Joints are hydraulically formed. Advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers you more application engineering experience. These are just a few of the reasons Zallea Expansion Joints can and do outlive the equipment they serve. Sooner or later, ordinary expansion joints hand you a bill for unscheduled downtime, lost output.

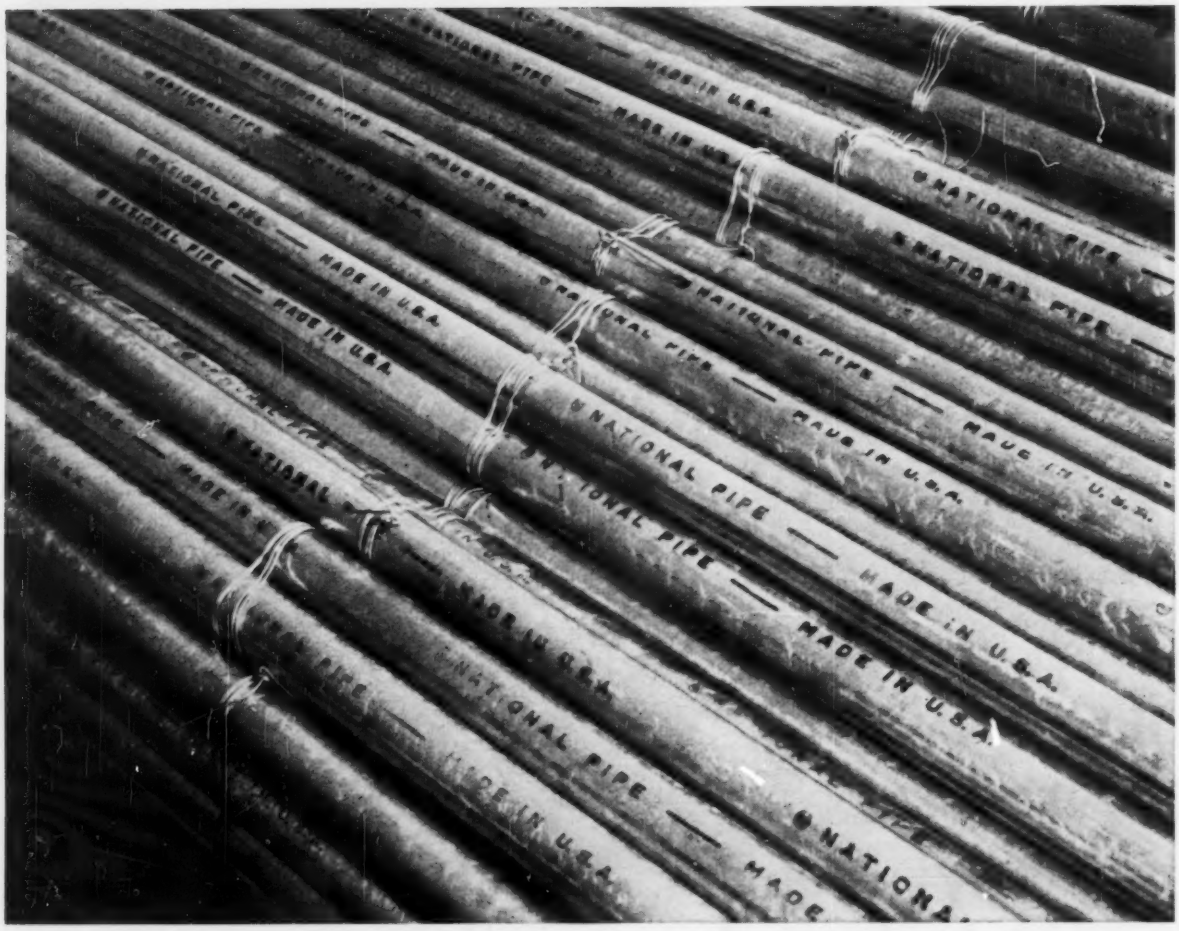
Got a tough one coming up? Call in an experienced Zallea design and application specialist. Knows every inch of his product, can assist with every facet of your problem. And write for catalog 56, Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea

for maximum reliability

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

This mark tells you a product is made of modern, dependable Steel.



Be sure the pipe you buy is marked "USS National Pipe... Made in U.S.A."

Take a good look at the next pipe you buy. Do you know who made it? How it was made? Its quality? If your pipe is marked "USS National Pipe—Made in U.S.A.," you can be sure you're getting high-quality steel pipe made on the most modern facilities by the largest pipe producer in the world. (National Tube led the way with its pipe-marking program.)

Order USS National Pipe from your local National Tube Distributor. You get fast delivery of the finest product from a man you can trust—a tough combination to beat!

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National Tube Division of United States Steel

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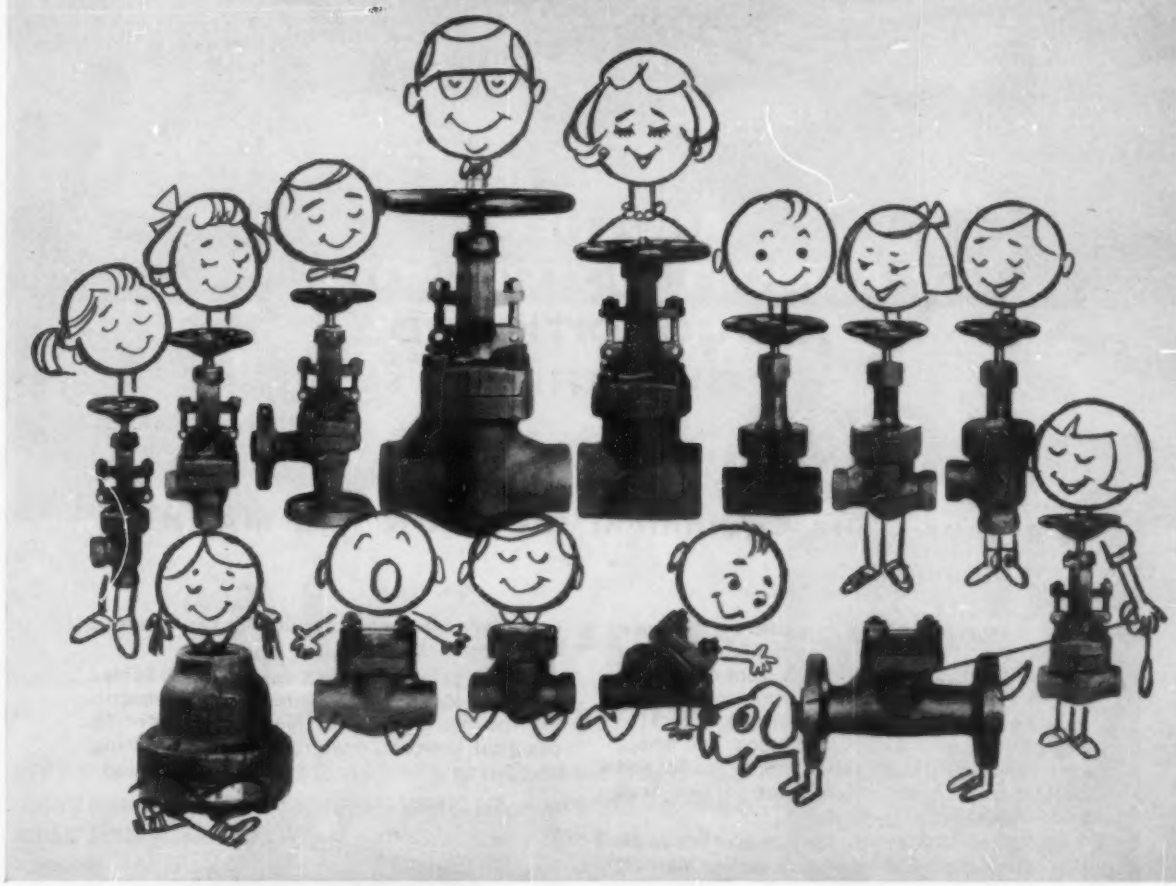
San Francisco Pacific Coast Distributors

CRANE'S LARGE FAMILY OF SMALL STEEL VALVES



CRANE 600-POUND STEEL GATE, GLOBE, ANGLE AND CHECK VALVES—¼" TO 2" SIZES—

gathered together for their first family portrait, from thousands of flow control assignments in every industry. In forged and cast steel; bolted and union bonnets and caps; outside screw and yoke or inside screw; Exelloy, Stellite*, Type 316 Stainless, Monel trims; reduced and full ports; screwed, flanged and socket-welding ends—one or more will meet every specific need. All share the Crane family trait of superior design, ruggedness and fine craftsmanship.

*Stellite is a registered trademark of Union Carbide Corp.

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For complete details contact your Crane Distributor, or write: Crane Co., Dept. X Industrial Products Group, 4100 So. Kedzie Ave., Chicago 32, Ill. In Canada: Crane, Ltd., 1170 Beaver Hall Square, Montreal.

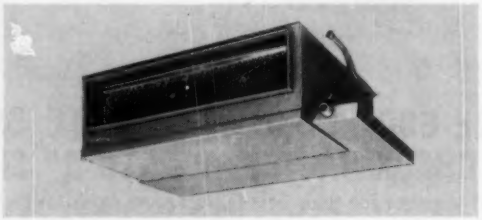
AIR CONDITIONED BY MARLO

Engineer Calls Equipment "BEST ON THE MARKET"

They haven't left a thing out of the new $5,000,000 Marriott Motor Hotel! Situated on a 10-acre tract just five minutes from downtown Philadelphia, it features 300 handsome guest rooms and suites, three restaurants, a cocktail lounge, barber and beauty shops, gift shop, nine meeting and banquet rooms, patio and pool, car rental service, 500-car parking area and heliport.

Delighted with the performance of Marlo air conditioning equipment in two earlier Marriott Motor Hotels in Washington, D.C., owners again specified Marlo for year-round comfort conditioning in this newest addition to the Marriott chain. Marlo Seazonaire fan coil units and central station units provide quiet, all-season comfort in guest rooms and larger areas. Marriott's engineer described this equipment as "the best on the market".

Architect for the project was William B. Tabler. Write for Marlo "Seazonaire" bulletin describing the many styles of Marlo equipment for practical, low-cost, multi-room air conditioning.



MARLO coil co.

Quality Air Conditioning and Heat Transfer Equipment Since 1925

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WORLD-WIDE DISTRIBUTION • Marlo International Ltd. P.O. Box Vaduz 34679 Vaduz Furstentum Liechtenstein

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Engineered to

RETAIN YOUR PRODUCT LEADERSHIP

ALCO *Designed*
Long Life
CONTOUR POWER ASSEMBLY

Increases life of diaphram and reliability on reverse cycle systems and general applications.

ALCO *Designed*
RAPID RESPONSE BULB — IN WELL

- Reduces danger of floodback
- Extra-quick closing response
- More efficient control over wider range of operating conditions
- Economical to install in package units
- Available on all gas charges

STANDARD RAPID RESPONSE BULB— STRAP ON or IN WELL

- Available in all charges

ALCO *Designed*
FOR SYSTEM EQUALIZATION

- Bleed port in body flange Not affected by servicing
- Cage and Power Assembly-Standard Parts

ALCO *Designed*
SERVICE OR CAPACITY CHANGE FEATURE

Change capacity or service easily without breaking connections or removing valve from line.

No special wrenches or gauges required.

Simply . . . loosen **2** bolts . . . lift out cage . . . for cleaning, servicing.

Follow same procedure for replacing identical Alco factory assembled and tested POWER ASSEMBLY or CAGE ASSEMBLY.

ALCO T-SERIES
THERMO® EXPANSION VALVES

• For R-12 from ½ ton to 50 tons, R-22 from 1 ton to 80 tons, R-500 from ¾ ton to 60 tons. SELECTIVE CHARGES AVAILABLE • BODY DESIGNS — STRAIGHT THRU or ANGLE STYLE • EXTERNAL or INTERNAL SUPERHEAT ADJUSTMENT • TIGHT SEATING . . . STAINLESS STEEL STEM AND SEAT . . . • HERMETIC TYPES ALSO AVAILABLE.

Call your ALCO WHOLESALER—write for Section 171-56. Bleed Port and Hermetic construction specifications on request.

ALCO VALVE CO. 861 Kingsland Ave. • St. Louis 30, Mo.

BUY SECURITY • BUY QUALITY • BUY ALCO

8218-2

The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors • Solenoid Valves Refrigerant Filter-Driers • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

CANADIAN AGENT: A. C. & R. Products Ltd., 2857 Lawrence, E. Scarborough, Ontario.
Excluding the provinces of British Columbia and Alberta.

How to gain effective insulation

Insulate and Protect Hot or Cold Underground Piping in One Operation

By GENE HOPPE,
Product Manager,
Witco Chemical Company, Inc.
Pioneer Products Division

Are you troubled by the problems involved in installing permanent underground hot and cold piping?—by the complexity of operations required to insulate, protect against corrosion and electrolysis and ward off water infiltration?—or by cracked concrete allowing exposure to ground chemicals and moisture? Here is your answer to effective insulation and protection. Now a material has been created that handles all these problems at one stroke—WITCOLITE®.

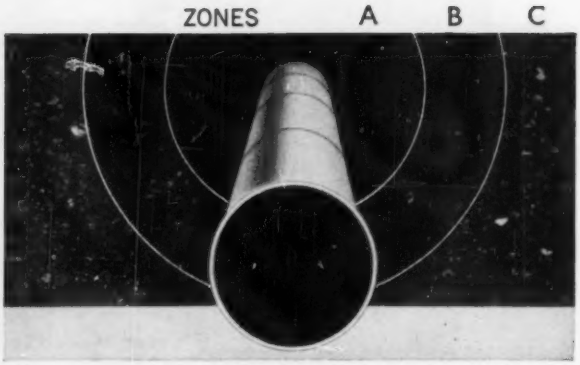
What is WITCOLITE?

WITCOLITE is a dry, granular, adhesive material, manufactured under carefully controlled conditions from resinous hydrocarbons of petroleum origin. It forms a permanent and flexible, highly effective insulating and corrosion-resisting structure around pipes when they are originally heated to recommended temperatures.

Estimated Wt of WITCOLITE

Pipe Size Inches	No. of 50-lb bags for 10 lineal ft
1 - 2	5
3 - 4	8
5 - 6	15
8	20
10	34
12	40
14	51
16	65
18	73
20	92

WITCOLITE is delivered to the job site in 50-lb bags. It is poured into a trench or form surrounding the pipe and tamped down with conventional equipment. Backfilling can be started after heat cure is completed.



How Does it Work?

As WITCOLITE is subjected to heat of piping, a 3-zone structure is formed: (A) Cured Zone—consisting of an insulating and anticorrosive area locked around pipe; (B) Sintered Zone—an air-pocketed insulating and moisture-resistant barrier; (C) Granular Zone—loose particles providing maximum thermal insulation.

Where is it Used?

WITCOLITE is used wherever hot underground piping is installed: industrial plants, refineries, public utilities, schools, institutions, municipal buildings and others. It can also be used with pipelines that alternately convey hot and cold liquids.

WITCOLITE TECHNICAL DATA

Thermal Insulation Value (K)	0.40 to 0.60 BTU per hr, per sq ft, per degree F, per inch of thickness Zone A 1.0 Zone B 0.40 Zone C 0.60	Flash Point 550°F Bulk Density 40 lbs per cu ft (Granulated) 1¼ cu ft per 50-lb bag; 50 cu ft per ton (Compressed) 45.0 lbs per cubic foot
Fusing Point	Grade A: 212° or less Grade B-1:212 to 300°F Grade B-2:300 to 360°F	Adhesion to Metal Lbs per sq in @ 77°F (Scott Tensilometer) Grade A: 255 Grade B: 275
Compression Strength Fused Zone @ 70°F (Soiltest compression tester)	Grade A: 1400 psi Grade B: 1460 psi	Steam Pressure (Gauge) 120 psi
Water Absorption Total Immersion 6 wks @ 77°F	Grade A: 0.732% gain Grade B: 0.701% gain	Approx Temperature Zone A 165°F Zone B 130°F Zone C 110°F

Complete information on properties and applications of WITCOLITE is given together with installation instructions in our Technical Service Bulletin W-22. Write today for your copy to Technical Service Dept 8107

WITCO CHEMICAL COMPANY, INC., PIONEER PRODUCTS DIVISION, 122 East 42nd St., New York 17, N.Y.
SALES OFFICES: NEW YORK • CHICAGO • LOS ANGELES • TORONTO AND MONTREAL, CANADA

PIONEER division of WITCO

EQUIPMENT DEVELOPMENTS

Welding Fittings Feature Ultra-Compactness

Greatly reduced in size, these welding fittings are for heating and cooling system piping and similar moderate and low pressure welded lines. Includes 90 and 45 deg elbows, straight and reducing tees, concentric and eccentric reducers, and caps in sizes 2, 2½, 3, 4, 5, and 6 in. Reducing tees and reducers have reductions in the intermediate IPS sizes down to one half of run or large end size. Ends are sized in thicknesses to match corresponding sizes, and thicknesses, of Schedule 40 pipe. All are seamless and made only in Grade B carbon steel. Designated as Class 125 for WOG rating, 175 psig; saturated steam rating, 125 psig. Described in bulletin 619. — *Taylor Forge & Pipe Works, P. O. Box* 485, *Chicago* 90, *Ill.*

Roof Mounted Units Have Multi-Applications

For heating only, with or without filters; heating and ventilating, with or without filters, and with manual or automatic dampers to proportion outside and return air; or heating, cooling and ventilating with manual or automatic dampers. Heating output range is 280,000 to 1,000,000 Btu per hr with an air volume range of 3000 to 15,000 cfm. Additive direct expansion evaporator units give 10 to 45 tons of cooling. Primary heat exchanger is 16 gage No. 430 stainless steel and meets UL standards when subjected to a 180 F air temperature rise over the heat exchanger. No internal baffles are employed. Secondary heat transfer surface consists of 16 gage aluminized steel tubing connected to stainless and aluminized headers. Both primary and secondary surfaces are covered by a standard 10-year warranty. Described in bulletin OG. — *Lennox Industries Inc., Marshalltown, Ia.*

Gas-Fired Duct Furnaces Available in Two Types

Unitary type is designed for single unit applications and is manufactured in four sizes ranging from 75,000 to 160,000 Btu per hr input. Sectional type is for use as individual units or combined in multiple unit banks for large systems. Capacities range from 215,000 to 300,000 Btu per hr. Both types include aluminized or stainless steel heat exchanger, built-in draft diverter, ribbon type burners with stainless steel ribbon inserts, and slip joint flanges on both intake and discharge for duct attachment. Feature automatic controls. — *John J. Nesbitt, Inc., State Rd. & Rhawn St., Philadelphia* 36, *Pa.*

Gas-Fired Hot Water Boilers Rated to 3,000,000 Btuh

Available in 16 sizes ranging in capacity from 200,000 to 3,000,000 Btu per hr. Largest model is 95 by 42 by 63 in. All sides are removable; burner slides out. Cabinet is made of 18 gage steel; base is 14 and 12 gage. Standard controls include electric gas valve, pilot safety control, gas pressure regulator, gas shutoff valve, ASME rated relief valve, combination thermometer and altitude gage, and aquastat. — *Cleaver-Brooks Co.,* 326 *E. Keefe Ave., Milwaukee* 12, *Wis.*

INFORMATION on capacities, dimensions, applications, and special features in each item is presented in accordance with material furnished by the manufacturers, who may be contacted directly for more details.

Other Departments . . .

Recent Trade Literature 179

We Hear That 185

Meetings and Conventions 187

New Books and Reports 190

THESE NEW HEAVY DUTY WRENCHES ARE DESIGNED TO REED STANDARDS OF TOUGHNESS, LONG SERVICE, AND SMOOTH, EASY USE.

Pearlitic malleable handle and housing are designed with heavy sections at the stress points, without sacrificing lightness and "feel."

•

Calibrated hook jaws are drop forged, milled and triple heat treated for toughness and long wear.

•

The patented double-spring action lets you grip and ratchet faster and with less lost motion.

•

Regular models in all lengths from 6" to 48". Offset design (for hard-to-reach corners) in 8", 10", 14" and 18".

•

Both designs meet or exceed Federal Specifications GGG—651c, Type 11, Class A.

See these new Reed Wrenches at your Jobber.
BUY them to save time, money and trouble.

* REED MANUFACTURING COMPANY
Erie, Pennsylvania

EQUIPMENT DEVELOPMENTS
Continued

Year Around Air Conditioners For Roof Mounted Installations

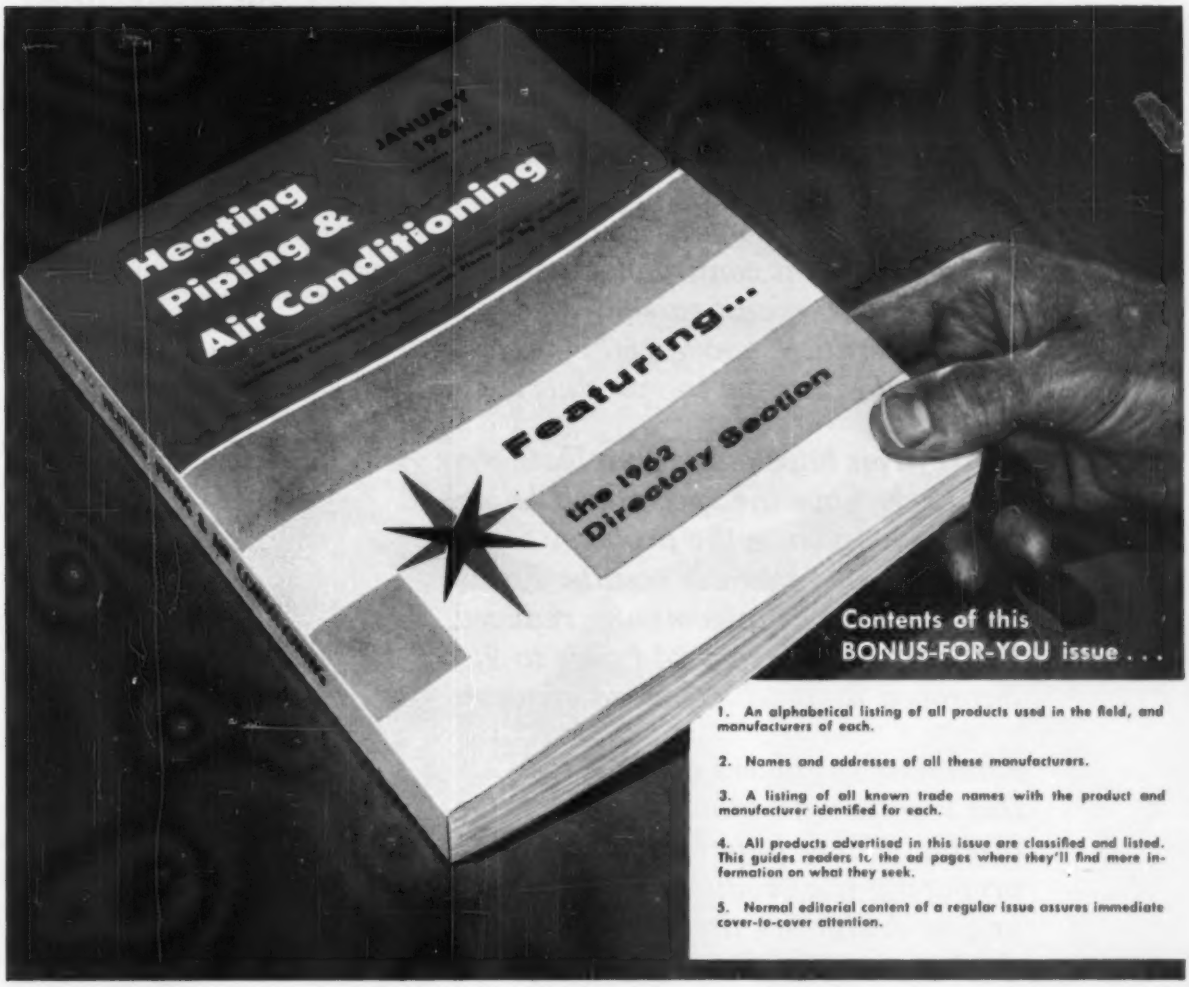
Self-contained "WAGH" series mounted on rigid iron channels and equipped with rigging holes at balance points to simplify installation. Foil-backed, glass fiber insulation is used throughout. Permanent-type, expanded aluminum filters are standard. Electrical system includes a 24 v control panel with a master disconnect circuit breaker. Furnace section is constructed of heavy gage aluminized steel. Cooling section features an air cooled condenser and a high volume centrifugal fan. All internal wiring is brought out to a numbered terminal strip. A matching terminal strip on the control panel (inside the building) facilitates installation. Available in models from 5 to 35 hp. — *Welbilt Air Conditioning and Heating Corp., Farmingdale, N.J.*

Extruded Aluminum Bar Grilles Available in Many Sizes

Feature different types of directional vanes, three different sizes of borders, and additional air blades which permit the air to be spread at very wide angles and short throws. Can be supplied either all anodized or in a satin brushed aluminum finish. — *Universal Diffuser Corp.*, 155 *Saw Mill River Rd., Yonkers, N.Y.*

Heat Pumps Available With 20 to 300 Ton Capacities

Both air to air and air to water units available. Based on positive forced feed circulation of the refrigerant through the respective summer or winter evaporator. No critical superheat, control settings govern heat pumps' operation. — *Worthington Corp., Air Conditioning Div., East Orange, N.J.*


Heating Piping & Air Conditioning
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NOTE

YOU CAN STILL MAKE THIS ISSUE — BUT TIME IS SHORT! *PHONE OR WIRE TODAY.*

Nowhere will your advertising dollar go farther . . . accomplish more! This is an issue that is a right-at-hand reference for the engineers and contractors you must reach. (In a survey of these *all paid* subscribers, 96% report they keep it throughout the year, 75% refer specifically to its advertising pages.)

No wonder nearly 300 advertisers appear each year! Make sure you too will profit from this all-in-one January issue with a Directory Section and regular editorial content. Start off 1962 impressively by using extra space for extra emphasis on your entire line. Regular space rates apply. KEENEY PUBLISHING CO., 6 N. Michigan, Chicago 2. Phone: 782-6916, Area Code 312.

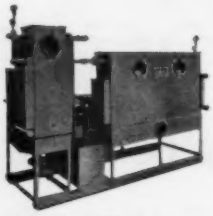
high-speed drying

of heat-sensitive products

You are asked to speed up a drying process; make it continuous instead of batch; but—can't raise the temperature above 150 F because that would damage the product!

Other firms have found that Kathabar engineers have the specialized knowledge to help solve the problem —often with dramatic results. For example, a gelatin company reduced its drying time from 24 hours to 2; improved its product; saved space.

Kathabar engineers achieve similar results with other heat-sensitive products. They have had experience in preparing the product, conveying it, and in designing the most effective drying medium. Take advantage of their fund of specialized knowledge...



KATHABAR®

where the experts turn for help

SURFACE COMBUSTION, 2384 Dorr St., Toledo 1, Ohio

a division of Midland-Ross Corporation MR

Send facts on high-speed low temperature drying: .....

.....

name & title .....

business address .....

street .....

city .....*zone* .....*state* .....

EQUIPMENT DEVELOPMENTS

Continued

Glassed Centrifugal Pump for Small Capacity Corrosive Service

Handles 2-½ to 75 gpm, creating heads from 10 to 90 ft. Glass is fused to metal on all surfaces coming in contact with the pumpage, providing resistance to corrosion and eliminating contamination of product and adherence of product to pump parts. With the quence gland and bearing cooling chamber, liquids up to 350 F can be handled. Described in bulletin 725.3 — *Goulds Pumps, Inc., 229 Black Brook Rd., Seneca Falls, N.Y.*

Two-Way Radio Has Transistor Power Supply

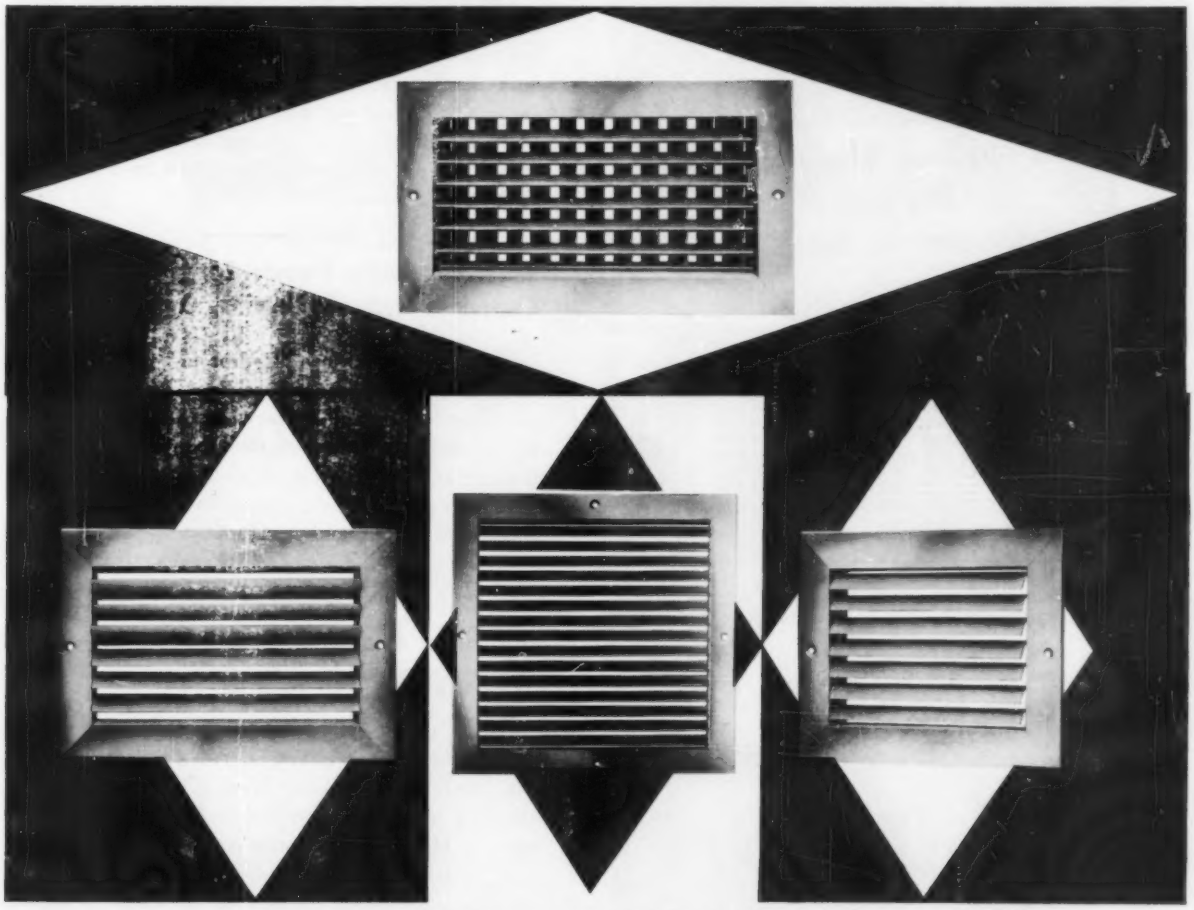
10 lb mobile radio has a transistor power supply in its control section to minimize maintenance and reduce battery drain. Does not require special generators or heavy duty batteries. All components are housed in one case, including a built-in speaker. Drawer-type construction permits unit to slide out for easier service. — *General Electric Co., Section P, Communications Products Dept., P. O. Box 4197, Lynchburg, Va.*

Solenoid Valve Provides Safety Shutoff

Manual reset, latched open two-way solenoid valve available for trip or safety shutoff in the handling of heavy fuel oil. Controls fluids at temperatures to 450 F at pressures to 200 psi. Valves are supplied with steel bodies and socket weld connection in 2 and 2-½in. sizes. The 2 in. size has a "Stellited" integral seat and stainless steel disc; stainless steel sets and disc are provided in the 2-½ in. size. NEMA 1 pressed steel, NEMA 4 watertight, and NEMA 7C, 7D explosion-proof solenoid enclosures are available. Described in bulletin No. V5143. — *Automatic Switch Co., Florham Park, N.J.*

STANDARDLINE

extruded aluminum grilles and registers withstand even salt air environment



YOU CAN COUNT ON STANDARDLINE
grilles and registers to retain their "just-installed" appearance even in the most destructive environments. All parts are of extruded aluminum . . . far stronger than rolled aluminum . . . and are impervious to rusting, pitting, corrosion . . . even in salt air.

Surfaces are etched to a rich lustre and coated with a clear acrylic lacquer. The fine finish serves as a perfect base for color-matching grilles and registers to an existing decor, without fear of "bleed-through" or need for a prime coating.

There is a T&B STANDARDLINE grille or register designed to fill the bill for your jobs. For more information, call your nearest T&B Representative or write us direct.

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Division of Allied Thermal Corporation
New Britain, Connecticut
Tuttle & Bailey Pacific, Inc., City of Industry, Calif.

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REG U S PAT OFFICE

DOUBLE CORE REGISTERS
with opposed blade dampers
key control
for Commercial Installations

No. 27
Adjustable Vertical Front Bars
Adjustable Horizontal Rear Bars

Rear View
Showing Volume
Control Dampers

Write for Catalog
No. 61 which gives
complete details and sizes
up to 48" x 24"

Always leading—Always Progressing

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3747 E. 93rd STREET · CLEVELAND, OHIO

EQUIPMENT DEVELOPMENTS

Continued

Convector and Fan-Coil Enclosures For School, Commercial Applications

Custom-fabricated wall-to-wall enclosures made from standardized components. Top cover snaps onto framing parts. End frames, mullions, and front panel use built-in adjustments to compensate for uneven floors and walls. Except for securing framing members to walls and floors, screws are not required during installation. — *Air Dynamic Div., Louis Sack Co., Inc., 24 Lake St., Somerville 43, Mass.*

Motorized Valves Provide Zone Control of Hydronic Heating, Cooling

Straight-through flow "Hydrozone" valves for use on hydronic heating and cooling systems, and for steam up to 10 psi. Features visual valve stem indicator to eliminate leaking at the valve stem; a "Viton" O-ring; and 100 percent shut-off. Type "Z-108" has ¾ in. sweat copper inlet and outlet; type "Z-208" has 1 in. sweat copper inlet and outlet. — *A. W. Cash Valve Mfg. Corp., Wabash and Morgan, Decatur, Ill.*

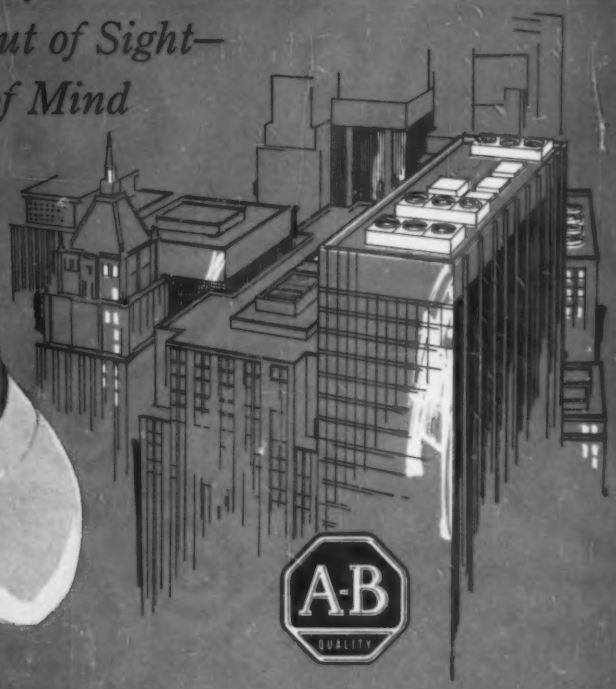
Humidifier Also Traps Dust, Water Soluble Odors, Minerals

"Mist-I-Cone" maintains relative humidity at 35 to 45 percent in winter. Consists of a quietly spinning cone that picks up water from a reservoir pan and throws it against a "breaker comb." This water saturates a high-porosity evaporating mat enclosing the unit. A self-contained fan pulls dry air into the unit's interior and forces it out through the mat. Air leaving the mat moves into the ventilation ducts at 90 to 95 percent relative humidity. A typical evaporation capacity is 1 gal per hr at 10 percent relative humidity and 70 F. Also acts as an air filter, trapping dust and odors. — *E. T. Holmgren, Inc., E-717 1st National Bank Bldg., St. Paul 1, Minn.*

Gas-Fired Make-Up Air Units Rated to 5,375,000 Btuh

Self-contained units available with an air delivery range from 22,000 to 70,000 cfm; and are rated from 2,125,000 to 5,375,000 Btu per hr. Three basic sizes provide six different ratings. Other sizes available on special order. Complete modulating controls provide a 25:1 turn down ratio. Controls also allow the units to be used for hot weather cooling. — *Robbins & Myers, Inc., Propellair Div., 1345 Lagonda Ave., Springfield, Ohio.*

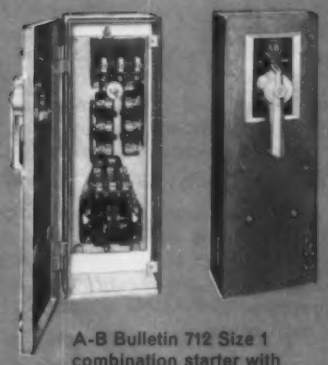
Allen-Bradley Motor Control
Out of Sight—
Out of Mind



Bulletin 709 Across-the-Line Starters and Air Conditioning Systems are a "Natural" Combination

Allen-Bradley Bulletin 709 starters have long been recognized as the starter "you can install . . . and forget!" However, today's new Series K Starters are better for these reasons: smaller size . . . really remarkable in the higher ratings; weld-resistant contacts . . . cadmium oxide silver that never needs servicing; tremendous switching ability . . . far beyond the heaviest duty requirements; molded coil . . . not affected by any atmospheric environment; coil removal and replacement . . . a matter of seconds . . . only a screwdriver required; trip-free and tamperproof overload relays . . . honest, reliable overload protection.

Frankly, you should find out all about this family of Bulletin 709 Series K Starters—there is no starter on the market today to equal it. Please write for Publication 6100: Allen-Bradley Co., 1335 S. First St., Milwaukee 4, Wisc.



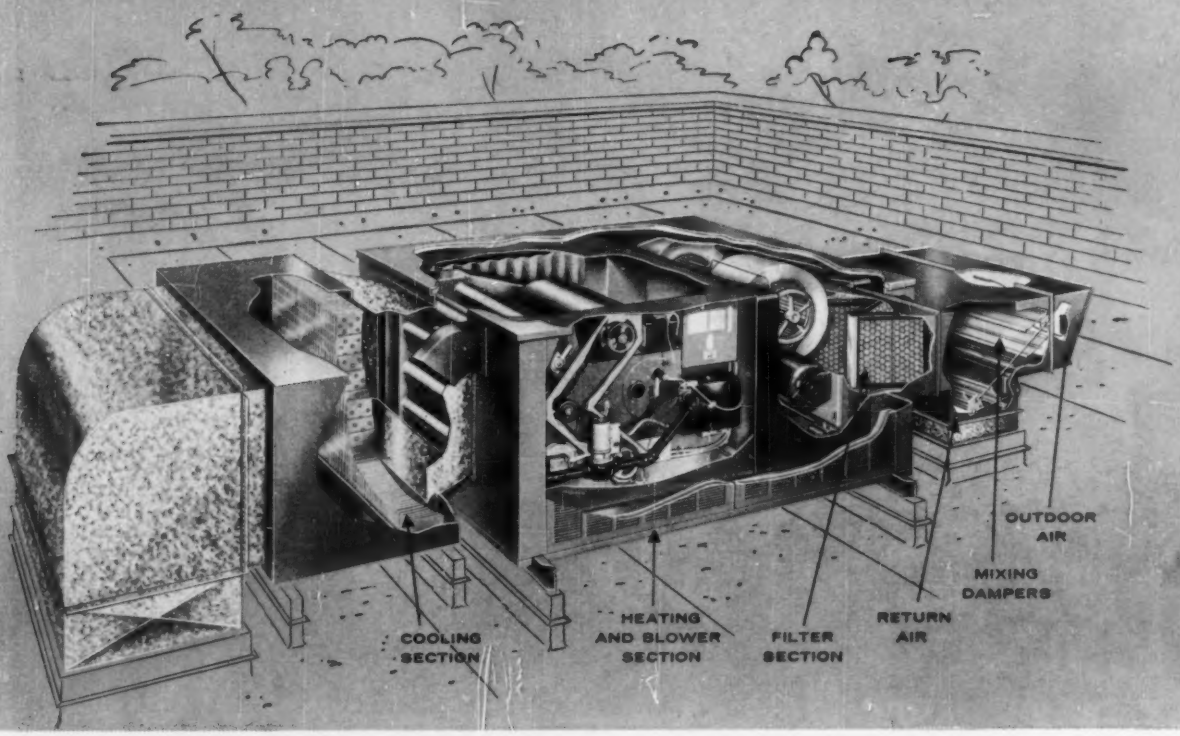
A-B Bulletin 712 Size 1 combination starter with fusible disconnect switch. Also available as Bulletin 713 with circuit breaker.

ALLEN-BRADLEY

Member of NEMA

Quality Motor Control

new from LENNOX



outdoor units FLEXIBLE enough to handle any heating–cooling–ventilating job

Flexibility of use

1. Heating-cooling-ventilating with manual or automatic dampers for outdoor air.
2. Heating and ventilating with or without filters and with manual or automatic dampers to proportion fresh air and return air.
3. Heating only, with or without filters.

From a space-saving roof top or ground slab installation, use this equipment as a central unit . . . or in multiples to serve different areas. Each section is completely weatherproofed and insulated. Sections come completely assembled, ready to be bolted to each other.

Flexibility of output

280,000 to 1,000,000 Btuh heating.

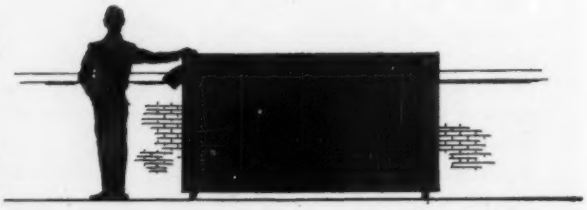
Air volume of 3,000 to 15,000 cfm.

8 to 35 tons cooling (installed initially or added later).

Can serve up to 20,000 sq. ft. of floor space.

Flexibility of fuel

Gas, oil or combination burners with either manual or automatic fuel changeover.



Low silhouette

Even the *largest* unit is only 58″ high installed. This includes flue outlet. Induced draft combustion system is built-in, eliminating a conventional flue.

"Free" cooling

Many days of the year, cooling is needed in a building even though outdoor air temperature is relatively low. In these cases, Lennox equipment brings in large volumes of outdoor air to cool the building without operating the cooling compressor . . . a big saving.

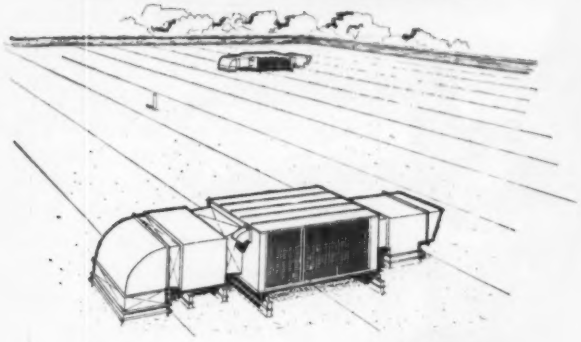
LENNOX a single source for heating, ventilating, air conditioning

Don't be satisfied with less than

LENNOX

on the

BIG JOBS



On big jobs, the so-called "little things" are still mighty important... things that add up to highest quality, extra convenience. Here are a few more reasons for specifying Lennox on your next job:

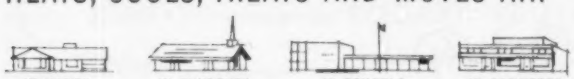
- *Exclusive Lennox-designed controls.* You get equipment *and controls* from one source. Room-mounted control center includes thermostat and convenient minimum position control for dampers.
- Protective service cavity for burners; a maintenance man's joy.
- Stainless and aluminized steel in heat exchangers and the combustion and induced drafts blowers. (Blowers welded to shaft to prevent slipping.)
- Refrigerant is sub-cooled in air-cooled condensing units. This, plus extra cooling coil surface, results in efficiency comparable to costlier water-cooled units.
- Time-tested components, proved in hundreds of installations throughout the world.

The complete Lennox line, and your Lennox representative, will make your designing and buying job easier . . . one central source for direct-fired heaters up to two million Btuh . . . cooling and ventilating for any job.

Don't be satisfied with less than

LENNOX

HEATS, COOLS, TREATS AND MOVES AIR



LENNOX INDUSTRIES INC., EST. 1895—MARSHALLTOWN, IA.; COLUMBUS, O.; SYRACUSE, N.Y.; DECATUR, GA.; FT. WORTH, TEX.; SALT LAKE CITY, UTAH; LOS ANGELES, CALIF. LENNOX INDUSTRIES (CANADA) LTD.—TORONTO, MONTREAL, CALGARY, VANCOUVER, WINNIPEG.

EQUIPMENT DEVELOPMENTS

Continued

Dehumidifier Removes Up to 300 Lb of Moisture Daily

Model "D20" employs a 2 hp hermetic refrigeration cycle to remove up to 36 gal of moisture daily. Operating range from 50 to 110 F DB, with relative humidities down to 40 percent. Standard components include automatic electric humidistat, magnetic starter, freezestat, 12-ft 3-wire electric cord, and pail compartment with 5 gal pail for locations where drain connections can not readily be made. Available for 208 or 230 v, 60 cycle; or 200 or 230 v, 50 cycle, single phase circuits. — *Remington Corp., Air Conditioning Div., Auburn, N.Y.*

Boiler Cleaning Process Uses Ammoniated Citric Acid

Removes magnetite and copper deposits from boilers. This single solution, self-passivating process leaves a silvery grey metal surface which is rust resistant. Uses non-toxic chemicals. — *Chas. Pfizer & Co., Inc., 235 E. 42nd St., New York 17, N.Y.*

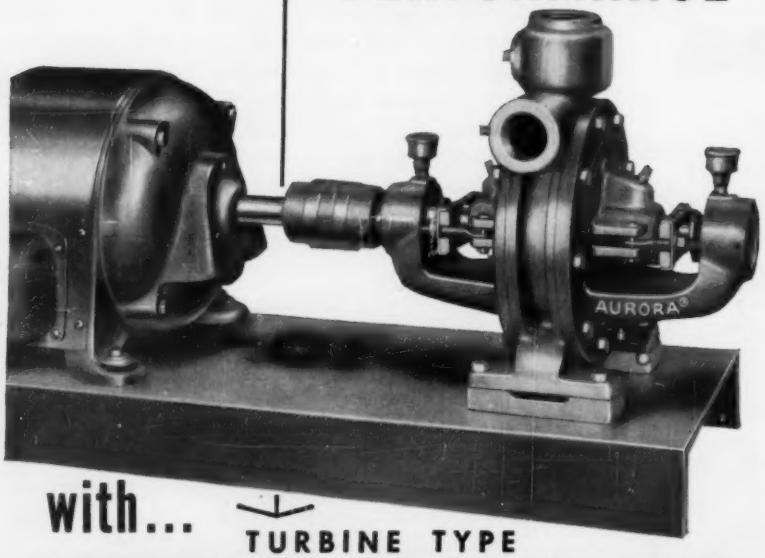
Electric Hammer-Drill Features Three-Way Action

Hammers with rotation, hammers without rotation, or drills without hammering action. "Roto-Hammer" drills holes in masonry, metal, wood, plastic, and other materials. Delivers 2400 blows per min and makes 500 rpm. Features die cast aluminum housing, ribbed for added strength; heat treated steel gears and aluminum piston; hardened alloy steel striker; and rear and side handle, and trigger switch. Model "726" drills holes from 11/64 to 1-½ in. in diameter; model "736" drills holes from ½ to 3-½ in. in diameter. A complete line of accessories is available. — *Skil Corp., 5033 Elston Ave., Chicago 30, Ill.*

Electromagnetic Flowmeter Responds to Fluid Velocity Only

Provides true volumetric reading of a wide variety of fluids and inconsistent slurries. Handles any liquid, including viscous, with no more pressure loss than that of an equivalent length of pipe. "Teflon"-lined flow tube and stainless steel electrodes protect against corrosion. A three-step range adjustment is available: 10, 50, and 100 gpm full scale. Continuous range adjustment is optional. Operates at temperatures to 150 F ambient and pressures to 240 psi at 200 F. Unaffected by ordinary industrial vibration. — *Hays Corp., 742 E. Eighth St., Michigan City, Ind.*

Profit by... CONTROLLED PERFORMANCE



with... TURBINE TYPE

APCO PUMPS

- PROVEN DEPENDABILITY
- CALCULATED CAPACITIES
- RUGGED CONSTRUCTION
- HIGHEST QUALITY CONTROL
- APPLICATION ANALYSIS
- SELECTED COMPONENTS
- MINIMIZED WEAR
- SERVICE FLEXIBILITY
- PRESSURES TO 400 P.S.I.
- CAPACITIES TO 150 G.P.M.

Ruggedness of construction and simplicity of design of APCO turbine type pumps combine to provide longer life, high efficiency, and minimized down time. This means more for your "pump operating dollar." With APCO *steep impeller* characteristics there is little capacity change under fluctuating head conditions. Select from the "1001" types, sizes, and capacities of AURORA pumps to obtain *the one* specifically designed to fit your needs.

APCO turbine type pumps are most frequently used for: Boiler Feed, Condensate Return, Fresh Water Service, Brine Service, Ice Water Circulation, Filter Service, LPG Service, Transfer Service, Caustic Liquid Handling, Sprinkler Service, Spraying Service, Water Treatment, Booster Service, and High Temperature Service.

WRITE TODAY FOR NEW BULLETIN S-111

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
650 LOUCKS STREET • AURORA • ILLINOIS

LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

EQUIPMENT DEVELOPMENTS

Continued

Unit Ventilator for Auditorium Applications

Designed for use with steam, hot water, or electric applications. Features a sound attenuator for quiet operation. Lined with 1 in. thick glass fiber insulation bonded with a thermo-setting plastic resin. Baffle placement provides 12 to 18 sq ft of absorption surface for each 1000 cfm. Absorption surface has a noise reduction coefficient of 0.70 to 0.80 in the range of 125 to 4000 cps. Motor and drive are enclosed. Available in nine sizes in a low pressure range, and seven sizes in a high pressure range. A full line of accessories is available. — *American Air Filter Co., Inc.*, 215 *Central Ave., Louisville* 8, *Ky.*

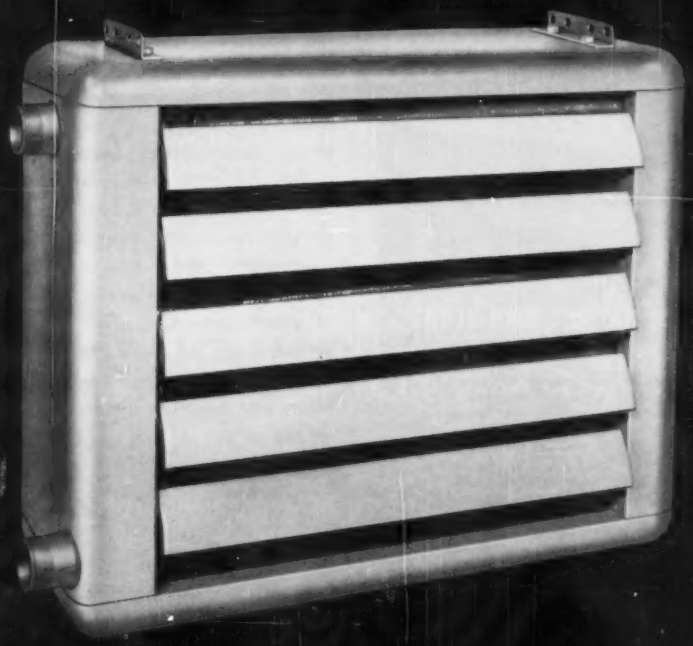
Air Impact Drill for Masonry Applications

Has high speed distintegrating action for cutting masonry products and reinforced concrete without deflection. Cuts openings from 3/16 to 4 in. in brick, masonry tile, and terrazo slate for anchors, pipe holes, etc. Drills holes from outside foundation; prevents spalling inside concrete wall. — *Stanley Power Tools, Dept. PD*, 195 *Lake St., New Britain, Conn.*

Recirculator Directs Ceiling Heat Back to Floor Level

Available in capacities from 280 to 30,000 cfm for application in high ceiling plants and other similar spaces. Suspended from ceiling; does not require a hole in roof. Fan pulls warm air into top of unit and diffuses it down through conical openings. Summer exhaust may be increased by suspending unit under gravity ventilators and reversing rotation of motor through a selective control switch. — *Genie-Air Products*, 3001 *E. 11th St., Los Angeles* 23, *Calif.*

NOW! 3 ways to judge superior design in the NEW KENNARD NELSON unit heater!



1 New High-Efficiency 2-Way Coil—Steam or Hot Water

2 Supply-Return Tappings On One Side of Unit

3 New Compact Cabinet Design Provides More Headroom

This is the new Kennard/Nelson Unit Heater. Its unique double-duty coil combines the optimum heat transfer requirements for *both* steam and hot water systems. The new Kennard/Nelson coil design permits the highest possible capacities and widest ranges available with *either* heating medium.

The unit is specially designed for easy installation. Supply and return tappings are conveniently located on the same side of the unit. This arrangement cuts piping and labor costs, makes snug ceiling and wall mountings possible, and gives a pleasing, uncluttered appearance. Compact cabinet design also provides more headroom.

Clip and return the coupon for complete information on the new Kennard/Nelson Unit Heater with its double-duty coil. Mail to: Engineered Air Systems Division, American Air Filter Company, Inc., 373 Central Ave., Louisville 8, Ky.

AAF **American Air Filter**
BETTER AIR IS OUR BUSINESS

Mail this coupon TODAY!

Please send me complete information on the new Kennard/Nelson Unit Heater.

Name_____

Company_____

Address_____

City_____ State_____

Unit in foreground is Type LG Breidert with translucent top providing an efficient, trouble-free skylight. More LG's and Type SG's are on buildings in background. This is the Consolidated High and Elementary School of West Clermont County, Amelia (Cincinnati), Ohio. Architect: Baxter, Hodell, Donnelly & Preston. Engineer: Ziel-Blossom & Associates.

Wherever you see new construction, you're apt to see...

BREIDERT AIR-X-HAUSTERS
BREIDERT POWAIR-X-HAUSTERS

More and more ventilator specifications call for Breidert Air-X-Hausters (gravity) and Breidert Powair-X-Hausters (power). Architects and engineers everywhere have learned that Breiderts provide safe, sure ventilation for all types of jobs, with a minimum of installation and maintenance problems. The attractive low contours of Breidert square and rectangular units are ideally suited to modern architectural design.

CERTIFIED CAPACITIES — GUARANTEED PERFORMANCE ▪ The capacities of Breidert ventilators are fully certified, performance is assured. Breidert Air-X-Hausters provides positive ventilation no matter which way the wind blows, barring interior negative pressures. Both gravity and power Breiderts are unconditionally guaranteed to deliver their rated capacities when properly installed.

IT PAYS TO SPECIFY BREIDERTS ▪ You can't match a Breidert ventilator for lasting satisfaction in performance and appearance. Contractors and engineers all over the country say, "In the long run, it pays to install a Breidert." We'll be glad to send you our 52-page Engineering Data Book with complete details about all Breidert ventilators. *On your next job, call the Breidert agent in.* There's one in or near your city. Consult your phone directory, your Breidert catalog, or write us for his name and address. Member A.M.C.A.

THE G. C. BREIDERT CO.
13690 VAUGHN STREET, PACOIMA, CALIFORNIA
MAIL ADDRESS: P.O. BOX 1190, SAN FERNANDO

EQUIPMENT DEVELOPMENTS

Continued

Through-the-Wall Heating Unit Designed for Adding Cooling

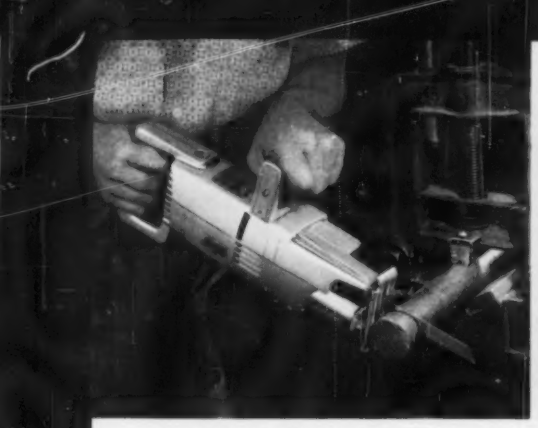
Can add cooling at time of installation or later with a 1 hp refrigeration package which fits into the unit. A heat pump package can be installed in the same way. Heats by steam or hot water from a central boiler, by electric resistance, or by the combination of a heat pump and electric resistance. Provides individual control and automatic changeover of heating to cooling. Consists of a two-speed fan, a coil for steam or hot water or an electric grid, an automatic control panel, a disposable filter, and movable directional grilles on top of the cabinet. — *Carrier Air Conditioning Co., Div. of Carrier Corp., Carrier Parkway, Syracuse 1, N.Y.*

Valve Allows Zone Control With Baseboard Heating System

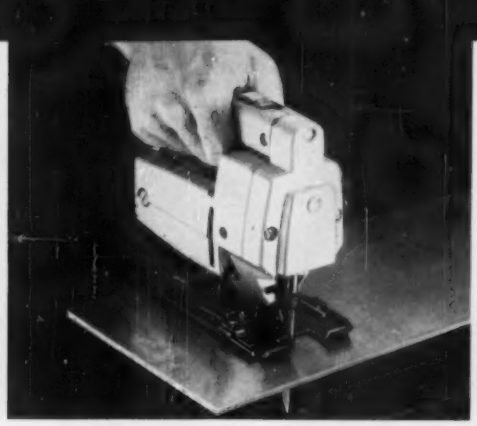
"Zone-A-Trol" installs on either the supply or return side of the radiation element to automatically control the flow of water through each zone, as called for by the controlling thermostat. Zone control possible in any multiple loop baseboard system without additional piping. — *Viking Instruments, Inc., Zone-A-Trol Div., East Haddam, Conn.*

Gas Conversion Burners Rated to 3,200,000 Btuh

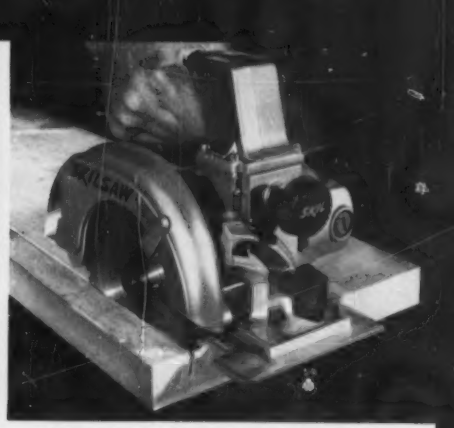
Capacities range from 400,000 to 3,200,000 Btu per hr. Available with a choice of three control systems: standing for 24 v, standing electronic, and intermittent full electronic for 115 v. Can be turned down to pressures as low as 0.1 in. WG and still burn; no flash back. — *The Barber Mfg. Co., 1052 E. 134th St., Cleveland 10, Ohio.*



NEW IDEA—Electric Hacksaw! Has 2 speeds for cutting all metals from stainless and cast iron to mild steel, non-ferrous metals (Model 701).



NEW IDEA—2-Speed Jig Saw! World's fastest—high speed for cutting wood, plastic, composition; low speed for metals (Model 160).



NEW IDEA—"Burnout-Protection" Motors. New ultra powerful saw motors backed by full year free service policy (on all Skilsaw circular saws).

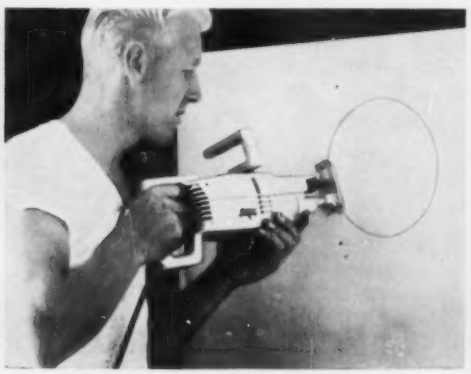
9 Do you know about these NEW SKIL Power Tool ideas?

NEW IDEA—Treaded Disc Sander Pad. Prevents disc slippage. Quick change nut locks on steel pins—no clogged threads (all Skil Disc Sanders).

NEW IDEA—2-Way Sander. Orbital action for fast sanding . . . straight line action for finest finishing! Big 4½" x 9" sanding pad (Model 692).

NEW IDEA—3-Way Hammer. Hammers, drills, does both simultaneously for fastest masonry drilling at lowest cost per hole (Model 726).

NEW IDEA—Low Cost Air Buffer and Grinder. Uses super-tough tungsten carbide rasps, rods. Complete kit—Model 412—$135.00.



NEW IDEA—Improved 2-Speed All-Purpose Saw. High speed cuts wood, plastic, compositions; low speed cuts metals (Model 700).

NEW IDEA—Lowest Cost Power Screwdrivers. For light to heavy duty production. Skil Model 139 sells for $45.00, reversing model 140—$53.00!

Ask your Skil distributor for demonstrations. Look under "Tools-Electric" in the Yellow Pages. Or write for 68-page catalog: Skil Corporation, 5033 Elston Avenue, Chicago 30, Ill., Dept. 134L

SKIL POWER TOOLS

Where people gather...CLEAN PURE AIR is VITAL

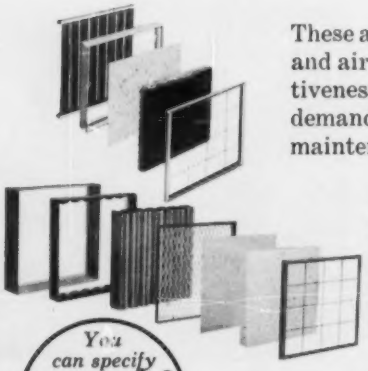
ARCHITECT: Heitschmidt and Thompson, AIR CONDITIONING CONTRACTOR: Air Conditioning Company, Inc. (Southern California), MECHANICAL ENGINEER: J. L. Hengstler

• At The Biltmore Hotel in Los Angeles, an atmosphere of clean, pure air is thoughtfully provided for guests and staff.

In the public areas, where it is necessary to permit entry of large amounts of vitiated outside air, combination replaceable media air filters and total detention type gas and vapor adsorbers by Burke are being used.

In the guest rooms, where 100% of the air is recirculated, combination replaceable media air filters and partial detention type gas and vapor adsorbers are in operation.

ROTOAire® CLEANS AND PURIFIES OVER A BILLION CUBIC FEET OF AIR DAILY IN THE BILTMORE HOTEL!



These are the advance design air filters and air purifiers that deliver the effectiveness, efficiency and dependability demanded by all modern building and maintenance programs.

They are readily adaptable to all new or existing installations.
They are available in a wide variety of sizes.
They may be operated at varying velocities and with various combinations of media.
The initial cost is low, but even more important . . . the maintenance cost is low.

You can specify ROTOAire® PRODUCTS with confidence!

Write for Technical Data Bulletin and "Economic Analysis."

Selected Territories Available For Qualified Representatives

BURKE *and* COMPANY
2902 Hyde Park Blvd., Los Angeles 43, California

EQUIPMENT DEVELOPMENTS

Continued

Electric Infra-Red Heater For Recess-Mounting

Suitable for installation in marquees of hotels, stores, theaters, etc. Features a golden finished, anodized aluminum reflector, frame, and louvers. Available in sizes from 11 to 43 in. in length, and capacities from 600 to 5250 watts. Has a choice of metal sheath, quartz tube, or quartz lamp heating elements. Input controllers and contactors or manual circuit switches are optional. Described in bulletin F74100. — *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

A-c Arc Welder Has 30 to 225 Amp Range

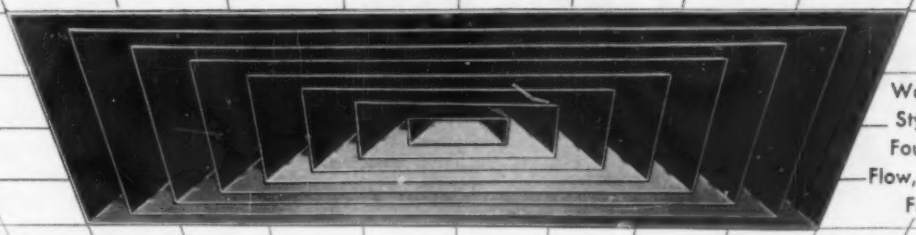
For regular 230 v, a-c circuits, unit operates with any type of a-c electrodes including low-hydrogen and stainless steel. Duty cycle is 20 percent. Range includes 12 stations, obtained by turning a dial on the front of the machine. — *Bren/Weld Corp., 5114 Third Ave., Brooklyn 20, N. Y.*

Clock-Programmers Have Single Swing-Out Case

Provide master program or master time and program control in a single swing-out case. Programmers are available for 1 or 5 min interval signaling on a 24-hr basis. Signals can be set for any duration from 2 to 25 sec. Special contacts available for sounding some signals longer than others. Units also available with a spring motor which drives the programmer for 12 hr after a power failure. — *Minneapolis-Honeywell Co., Commercial Div., 2753 Fourth Ave. South, Minneapolis 8, Minn.*

NOW! by Waterloo - Anemostat

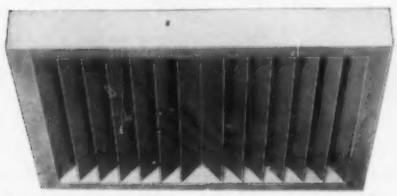
THE FIRST
ALL EXTRUDED ALUMINUM
TYPE D DIRECTIONAL DIFFUSER



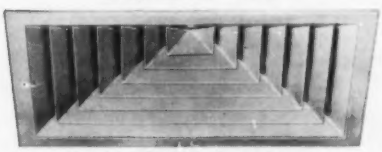
Waterloo Style DE Four Way Flow, Snap-in Frame

SQUARE and RECTANGULAR DESIGNS

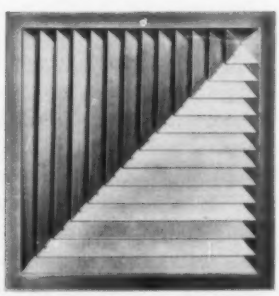
Waterloo Style DM One Way Flow Bevelled Frame



Waterloo Style DD Two Way Opposite Flow Drop Collar Frame



Waterloo Style DF Three Way Flow Flange Frame



Waterloo Style DL Two Way Corner Flow Lay-on Frame

★ **EASIEST TO INSTALL**

★ **ONE-THIRD THE USUAL WEIGHT**
because of aluminum construction

★ **LONG-LASTING**
All extruded aluminum

★ **5 FRAME STYLES • 14 CORE PATTERNS**
All cores removable and interchangeable

Mounting the Waterloo Style DE Four Way Flow Directional Diffuser Snap-in Frame

DESIGNED BY WATERLOO
... pioneer in development of air diffusion equipment in EXTRUDED ALUMINUM

PERFORMANCE PROVED BY ANEMOSTAT
in the finest laboratories in the air conditioning industry

CATALOG 7-61 AVAILABLE ON REQUEST.

WATERLOO *Air Diffusion* EQUIPMENT

WATERLOO REGISTER COMPANY, INC.

P. O. BOX 147, WATERLOO, IOWA

WR-124

LOW PROFILE

Burt *Spun Aluminum*

Direct and V-Belt Drive Centriflow Fan Ventilators

For institutions and other structures where a high capacity, low contour ventilator is required.

direct drive spun units

V-belt drive spun units

- 25 BASIC selections of tip speeds and capacities in direct drive models.
- 64 BASIC selections of tip speeds and capacities in V-belt drive models.
- CAPACITIES from 65 to 27,648 CFM.
- HORSEPOWER ratings from 1/60 to 7½.
- SIZES from 6" through 48" wheel diameters.
- STATIC PRESSURE range from 0" through 1" W.G. (higher static pressures on application).
- LOW PROFILE heavy gauge spun aluminum housings.
- NON-OVERLOADING backward curved, non-sparking aluminum fan wheels.
- ADJUSTABLE SHEAVES on V-belt units to change capacities at anytime.
- DAMPERS available in drop-in sleeve type, automatic back-draft or motor operated.
- BURT DESIGNED for minimum noise levels.
- AMCA CERTIFIED capacity ratings for units of 16" wheel diameter and larger.

Send for FREE *Data Book!*

Write for Centriflow Data Book SPV-12C-160 and Burt Data Book SPV-101-H which supplies quick data on Burt's complete line of modern Roof Ventilators

FAN & GRAVITY VENTILATORS • LOUVERS • SHEET METAL SPECIALTIES

The Burt Manufacturing Company

41 E. South St. Akron 11, Ohio

MEMBER AIR MOVING & CONDITIONING ASSOCIATION, INC.

EQUIPMENT DEVELOPMENTS

Continued

Packaged Boiler Features Trouble-Finding Safety Controls

Automatically indicates any cause of safety shutdown due to ignition failure, or shortages of water, fuel, electricity, or combustion air. Delivers 5000 to 6000 lb of steam per hr; in multiple installations up to 72,000 lb of steam per hr, depending on application. Safety lockout annunciator system operates by means of a group of indicator lamps located on the control panel of the boiler. Also features an automatic oil level safety control and a cooling system incorporated in the pump head. — *Clayton Mfg. Co., P. O. Box* 550, *El Monte, Calif.*

Disposable Air Filter Contains Hexachlorophene

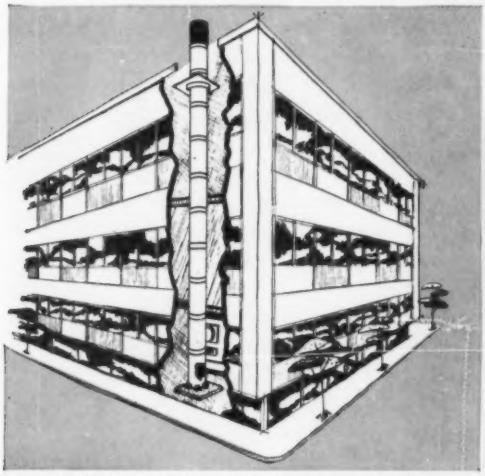
Made of closely interwoven continuous glass fibers, treated with hexachlorophene. Traps and holds dust throughout the filter core, not just on the surface. —*United States Gypsum Co.,* 300 *W. Adams St., Chicago* 6, *Ill.*

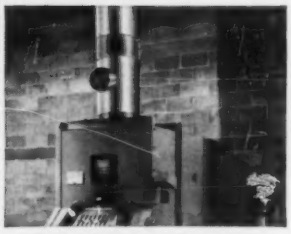
Reducing Valves for Hydronic Heating Boilers

Type "A-41" features an all-iron body and spring chamber, "Ircodipped" to inhibit rust. Noiseless filling operation is accomplished by the internal yoke design. Seat disc and diaphragm are heat resistant. Body seat is monel. A built-in check prevents flow of boiler water into potable water supply. Available in ¾ in. only with inlet and outlet for screwed connections. Described in bulletin HYD-1. — *A. W. Cash Valve Mfg. Corp., Wabash and Morgan, Decatur, Ill.*

FLINTKOTE® **VAN-PACKER®** Refractory Industrial Stacks

Solving Industrial Stack Problems





Van-Packer stack is easily installed inside most buildings. Its use permits greater freedom of location for the boiler or incinerator. The Van-Packer Model HT stack is the only commercial or industrial stack listed by Underwriters' Laboratories, Inc.

Van-Packer Model BF stack for boilers and furnaces

In addition to the UL-listed Model HT stack which handles incinerators with flue gas temperatures up to 800°F (up to 2000°F for occasional brief periods of forced firing), Van-Packer also offers the Model BF stack (not UL listed). This low cost refractory stack is ideal for boilers and furnaces with flue temperatures to 800°F. It is identical to the Model HT stack except for the refractory formula used in casting the stack sections, and is available in the same inner diameters.

For complete information on Van-Packer industrial stack, write for Bulletin IS-49.

Van-Packer industrial stack is easily located inside tall buildings

More and more architects and designers are specifying Van-Packer industrial stacks to simplify design requirements of their buildings and at the same time permit greater floor plan flexibility and more pleasing architectural effects.

Factory-built of 3-foot insulating refractory sections, the Van-Packer Model HT stacks can be located anywhere inside (or outside) the building to handle virtually any commercial or industrial incinerators as well as boilers or furnaces. You need allow only a 4-inch clearance to non-combustible construction to meet Underwriters' Laboratories specifications. Where the stack passes through combustible floors, a special insulating refractory thimble fits around the stack section and requires no additional clearance. This thimble is also used together with the Van-Packer flashing and counter flashing where the stack passes through combustibles at the roof.

Van-Packer stack sections are encased in an aluminized steel jacket which needs no routine painting or maintenance. Thus, your design can be made with minimum provision for stack accessibility.

The Van-Packer stack can be installed on concrete or brick pier foundations, floor supported, supported by wall brackets, or super-imposed directly on the incinerator or boiler. Where breechings are required, merely specify a Van-Packer straight section for that purpose. It is easily connected to the tee section opening, which has inner diameter equal to that of the stack.

Van-Packer stacks are available in sizes to meet virtually all application requirements, with these inner diameters: 10, 12, 15, 18, 21, 24, 30, and 36 inches. Cost of a Van-Packer is about the same as a steel stack for a comparable application, yet the non-corroding refractory construction results in an average life three times longer. Draft provided is equal to that of equivalent brick stacks (greater that that of equivalent steel stacks), assuring more efficient operation of the equipment served.

For residential use, specify Van-Packer all-fuel chimney

Here's a low-cost, factory-built tile-lined residential chimney that's safe and attractive. Specify either metal or asbestos-cement housing with embossed brick design. Choice of four non-fade brick colors: red, white, buff, and gray. Factory-built 2-foot flue sections have 5/8-inch fire clay tile liner, 3-inch vermiculite-concrete insulating wall, and asbestos-cement outer jacket. Van-Packer chimney is UL-listed for all fuels, is safe for incinerators. Write for Bulletin RS-1.

FLINTKOTE® **VAN-PACKER®**

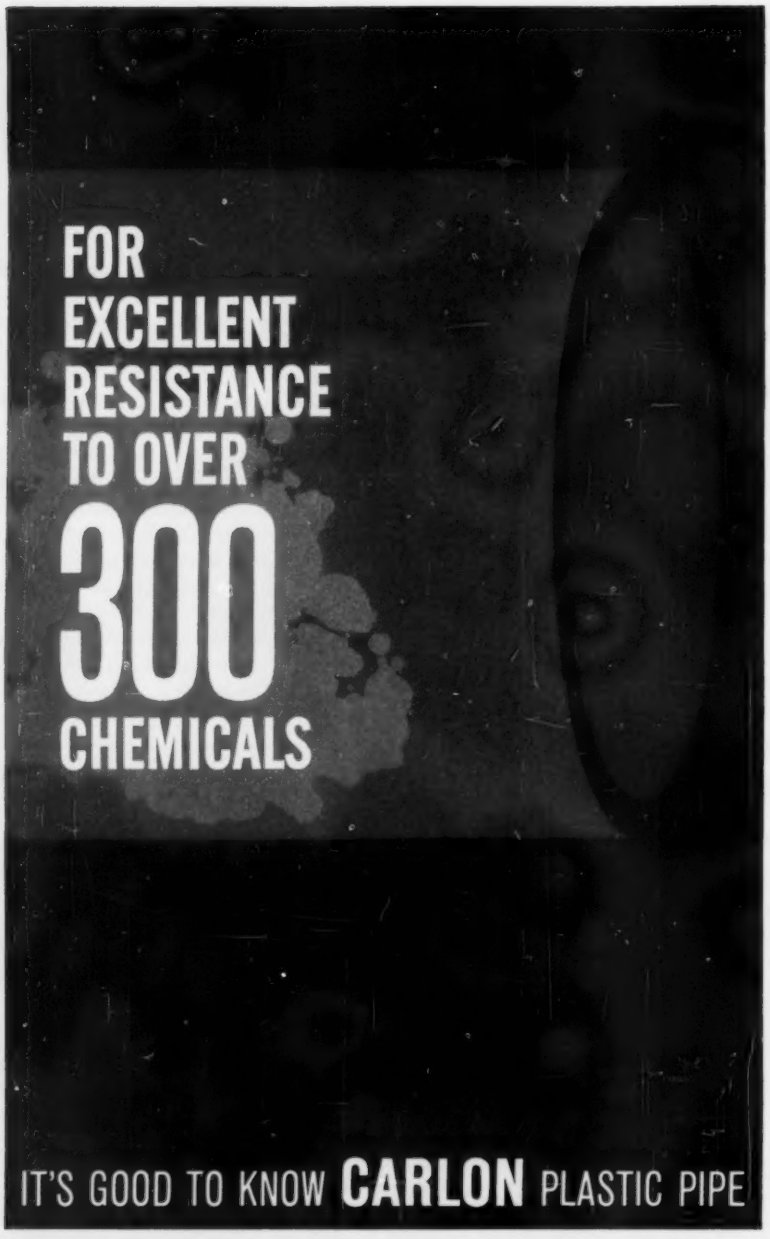
The Flintkote Company

Manufacturers of Diversified Products for Home and Industry

30 Rockefeller Plaza, New York 20, N. Y. Phone: PLaza 7-5500

In the West: Pioneer Division, The Flintkote Company, P. O. Box 2218, Terminal Annex, Los Angeles, Calif.

In Toronto, Ontario: The Flintkote Company of Canada, Ltd.



To help you make major pipe savings . . . Carlon's new Plastic Pipe Fact-pak. Includes chemical names, solution-strengths, operating temperatures and pressures. *Write for yours.*

KNOW THE FIRST NAME IN PLASTIC PIPE
CARLON

CARLON PRODUCTS CORPORATION
Box 133 — Aurora, Ohio — Dept. HP-4
Please send me the new Plastic Pipe Fact-pak.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

EQUIPMENT DEVELOPMENTS

Continued

Self-Cleaning Air Filter Uses Permanent Filter Media

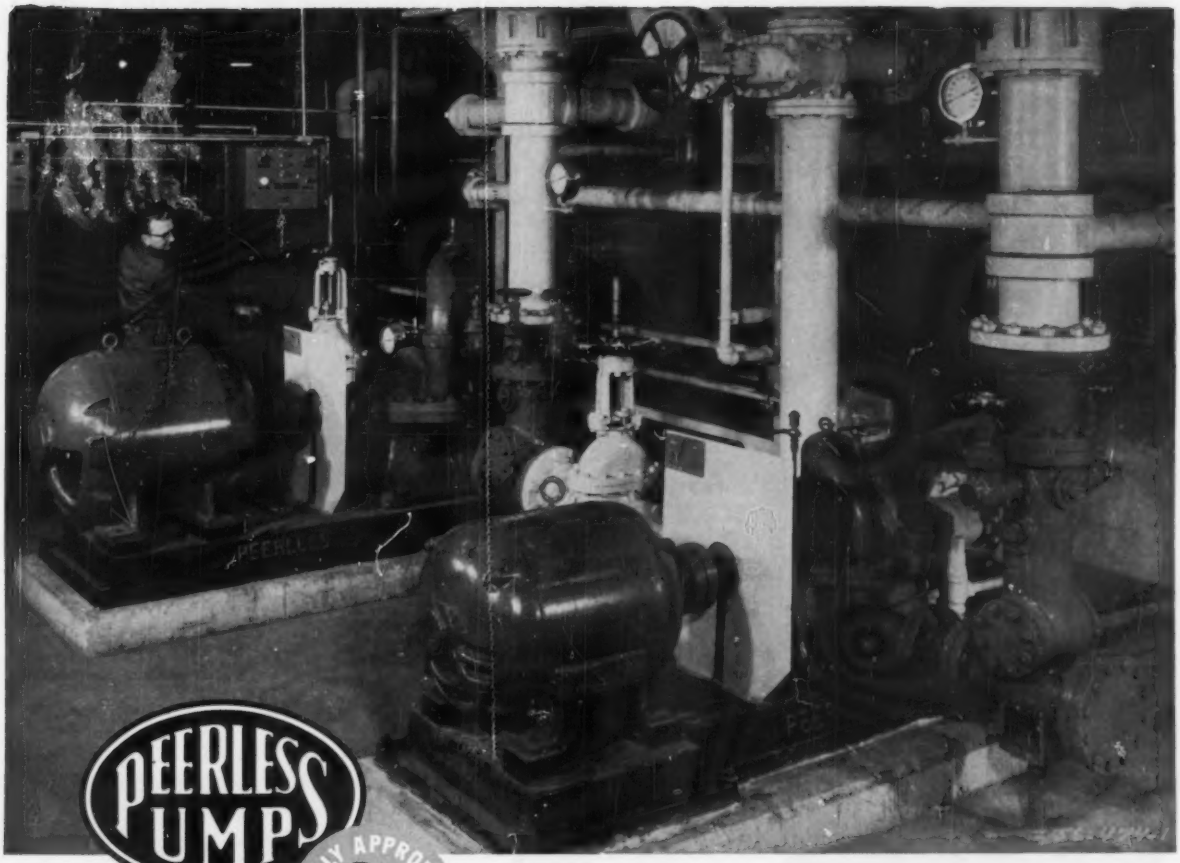
Incorporates the use of permanent filter media and a self-cleaning mechanism which removes impinged solids from the surface of the filter. The stripper traverses the filter surface on a governable cycle. A flexible hose connects the moving stripper to a vacuum and disposal container. Filter material or group of materials are supplied according to application. Units can be installed over existing filter housings. — *Honan Associates, Inc., Dept. NP* 108, *P.O. Box* 271, *Lebanon, Ind.*

Pump Controls for Elevated Or Pressure Tank System

An electrically-isolated pointer triggers the control as it indicates pressure variations, thus eliminating trial settings. Gage can be set in 2 sec. Units are available with starters and breakers in the same enclosure for automatic operation. — *Automatic Control Co.*, 995 *University Ave., St. Paul* 4, *Minn.*

Portable Infra-Red Heaters Constructed Entirely of Metal

Units have a nickel alloy grid of "Inconel" metal that withstands thermal and mechanical shock. No moving parts. Use propane gas, but are adaptable for natural gas. Units and tanks are mounted on wheels for complete portability. Available in 50,000 and 25,000 Btu per hr models that accommodate up to 100 lb propane tanks; and also a smaller 25,000 Btu per hr model for use with tanks up to 10 lb. — *The Van Dorn Iron Works, Infra Red Div.*, 2685 *E. 79th St., Cleveland* 4, *Ohio.*



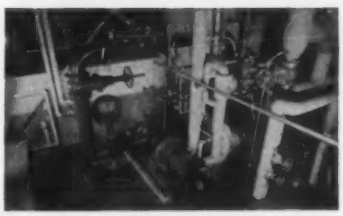
PEERLESS FULLY APPROVED FIRE PUMPS . . .

Peerless pumps give immediate protection against fire *automatically*, without human attention.

HOW TO DEAL WITH A FIRE BEFORE IT STARTS!

To insure adequate protection against the hazards of fire, a qualified independent fire protection system is a must. And to be doubly sure of the best system, the vital heart of the unit, the pump, should be the best money can buy. That's where Peerless *fully-approved* fire pumps excell.

Throughout a third of a century, Peerless fire pumps have attained an enviable and pre-eminent reputation in protecting all types of buildings, plants and warehouses. Put this know-how to work on your protection problem. See how Peerless' combination of top quality fire pump equipment, exacting engineering application and nationwide service can serve you best. In many instances, the savings effected thru more favorable insurance premiums can pay for the installation. For fire pumps at their very best look to the leader, look to Peerless. Write for bulletin B-1500 today.



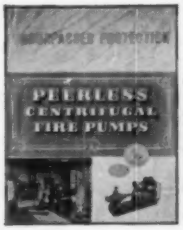
Available with steam turbine, engine or electric motor drives, Peerless fire pumps are available for high pressure sprinkler systems, or foam smothering systems in every kind of commercial, or industrial installation.

Putting Ideas to Work

Peerless Pump
HYDRODYNAMICS DIVISION

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION

Plants:
Los Angeles 31, Calif. and Indianapolis 8, Ind.



Peerless Pump, Hydrodynamics Division, Food Machinery and Chemical Corporation
2005 Northwestern Ave., Indianapolis, Indiana

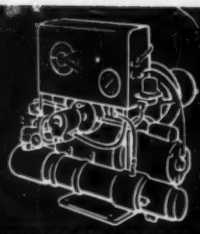
Gentlemen: Please send me immediately a copy of your Bulletin B-1500.

NAME_____

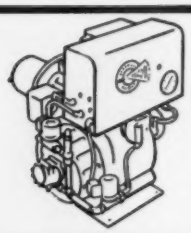
COMPANY_____

ADDRESS_____

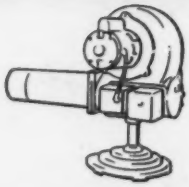
CITY_____ ZONE_____ STATE_____



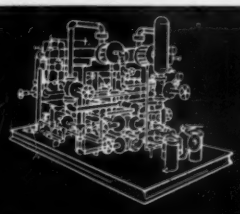
C-45 PRESSURE ATOMIZING OIL BURNER . . . forced or natural draft . . . for number 5 or lighter fuel oils . . . 7 models to 33 gph . . . UL approved. BULLETIN 100A.



C-20 PRESSURE ATOMIZING OIL BURNER . . . forced or natural draft . . . for number 2 fuel oil . . . 7 models to 33 gph . . . UL approved. BULLETIN 102.



NAIROIL AUTOMATIC OIL BURNERS . . . for firing small steam or hot water boilers, etc. . . . 4 sizes available ranging from ¾ to 20 gph of number 2 fuel oil. BULLETIN 113B.

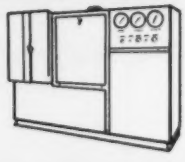


PUMPING AND HEATING UNITS . . . for problems involving heavy fuel oil for combustion. Single or duplex units from 2 to 100 gpm in standard or special models. BULLETIN 40.

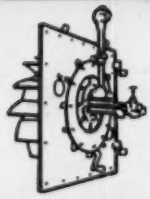
Check Your Fuel Firing Needs

From National Airoil . . . you can obtain a complete line of top-quality oil burners, gas burners and related combustion equipment shown here. Check your needs . . . we'll be happy to supply you with engineering data and assistance. No obligation, of course.

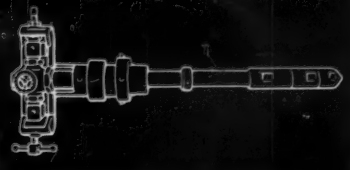
DUAL STAGE OIL BURNERS . . . for use when both mechanical and steam atomizing principles are incorporated in a single oil burner. 3 standard sizes. BULLETIN 25.



AUTOMATIC PACKAGED FIRING UNITS . . . Steam atomizing automatic firing units for oil and/or gas fuels. Standard unit capacities from 200 to 830 boiler horsepower (7,200 to 30,000 lbs of steam per hour). Larger units for special needs. BULLETIN 25.



UNIVERSAL REGISTER UNITS . . . a wide range of models including swing-type are available with capacities ranging from 60 to 500 gph. BULLETIN 51.



STEAM ATOMIZING OIL BURNERS . . . for use where steam or compressed air is available for firing many types of industrial process furnaces. 5 sizes have rated capacities from 10 gph to 725 gph. BULLETIN 23.

Established 1912
Incorporated 1917

NATIONAL AIROIL BURNER COMPANY, INC.
1284 E. Sedgley Avenue • Philadelphia 34, Pa., U.S.A.
Industrial Oil Burners, Gas Burners and Combustion Equipment

EQUIPMENT DEVELOPMENTS
Continued

Iron Couplings and Rubber Gaskets Connect Plain End Pipe

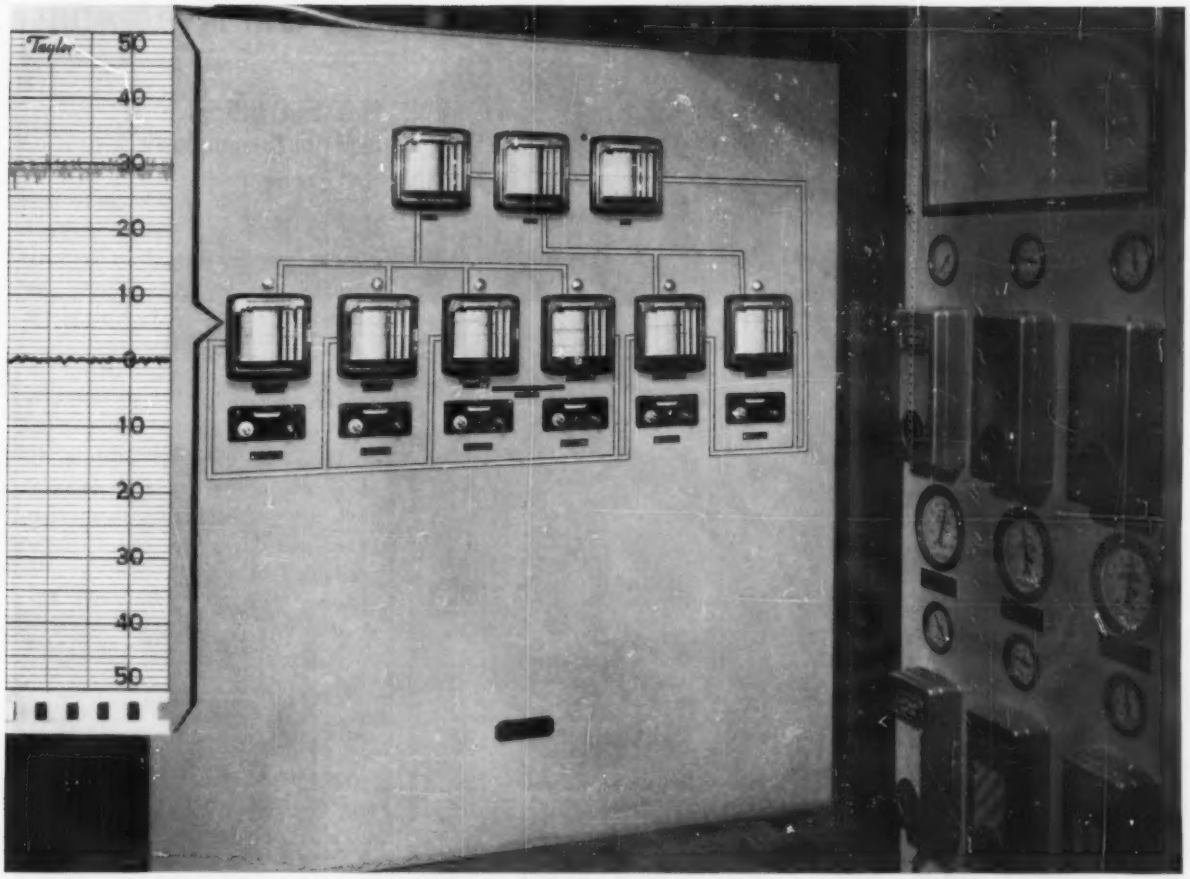
Available in sizes from 1 to 6 in. diameters. A "Hycar" rubber gasket is centered over the pipe ends and covered by iron coupling halves fitted with stainless steel grips. When coupling halves are bolted together, steel grips engage the pipe ends and lock them together. Recommended for general services including water, air, and other fluids at temperatures up to 180 F. "Hycar" rubber is a product of the B. F. Goodrich Chemical Co. The gaskets are molded by the General Rubber Co. — *Victaulic Co. of America, P.O. Box 509, Elizabeth, N.J.*

Strap-Type Pipe Clamp Has Vibration-Proof Lock

"Lock-Seal" clamp gives a positive seal on hose or plastic pipe connections. Five sizes will fit hose or pipe from 1 to 7-½ in. OD. Available in electro plated steel or Series 18-8 stainless steel. — *Murray Co., 11 W. Pennsylvania Ave., Towson 4, Md.*

Dehumidifiers Utilize Permanent Desiccant Structure

Provide continuous, non-cyclic operation with no liquids, granules, dusting, or loss of desiccant. Dewpoints of −40 F created without refrigeration. Capacities range from 25 to 10,000 cfm. The permanent desiccant structure is pierced with corrugated flutes in the form of a slowly rotating disc or wheel which passes progressively through an air stream which it dries and a heated air stream to which it gives up moisture. Described in bulletin No. 3003. — *Cargocaire Engineering Corp., 15 Park Row, New York 38, N.Y.*



Taylor control panel (center); Johnson Service Panel (right); in Bausch & Lomb Precision Scale and Grating Laboratory, Rochester, N. Y. Upper line of chart section shows air supply temperature; lower line is controlled temperature in ruling cell. (Full range of chart equals 1°F.)

Temperature controlled within $\pm\frac{1}{100}$ of 1° F.

BAUSCH & LOMB
RELIES ON TAYLOR TO KEEP
CRITICAL TEMPERATURES
CONSTANT!

Bausch & Lomb's Precision Scale and Grating Laboratory in Rochester, New York, is famous for its "Certified-Precision" gratings used in spectrographic analysis. Specially prepared optical glass blanks are diamond-cut to densities up to 270,000 grooves per inch. Spacing accuracy between lines is maintained at better than 0.01 of a micron. This kind of accuracy demands constant, precise control of temperature. That's why Bausch & Lomb and John W. Furlow Engineering Co. of Philadelphia, Pa., selected Johnson Service and Taylor Controls to do the precise job of controlling.

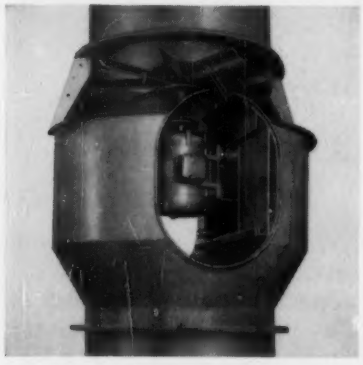
The heart of the underground laboratory consists of four ruling cells where the temperature is controlled at 68° F.±0.01. These are contained in an "envelope" area with a controlled temperature of 68°±0.25.

Temperature is measured with precision platinum resistance elements in conjunction with a Taylor 700T Potentiometer Transmitter, calibrated for a 1°F. span. Taylor TRANSCOPE® Electronic Indicating and Recording control stations are used in cascade control loops where saturable core reactors are the final control element of electric heaters.

Whether you will ever need ±1/100 of 1°F. accuracy, you can be assured that Taylor Control will dependably deliver what is required—whether for human comfort or maintaining product quality. In any event, be sure to specify, "Taylor Equipped As Usual". Ask your Taylor Field Engineer or write Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.

Taylor Instruments **MEAN ACCURACY FIRST**

SLIDE-OUT MOTOR AND FAN* cut your maintenance costs



Simply removing patented half-section of cone (left) allows motor-and-fan assembly to slide on rails (above) right out of DeBothezat Bifurcator for quick and easy inspection and maintenance. Bifurcator housing, originally installed as a section of the duct work, remains in place. This ease and convenience result in quick work which sharply cuts your maintenance costs.

DIRECT DRIVE CUTS COSTS, TOO

Direct drive eliminates inefficiency and maintenance problems of belts, yet motor operates in cool, clean air. Twin ducts of Bifurcator carry abnormally hot, corrosive or explosive fumes **around** motor, isolate it from destructive fumes handled by direct-drive exhaust fan. Fan wheels available from 12″ to 48″.

*Optional extra. Patents Pending.

Write for illustrated Bulletin DB-7-61

AMETEK

DeBOTHEZAT FANS

A DIVISION OF AMETEK, INC.

Dept. HPA-1261, EAST MOLINE, ILLINOIS

EQUIPMENT DEVELOPMENTS

Continued

Pipe and Fittings Clad in Thermoplastic

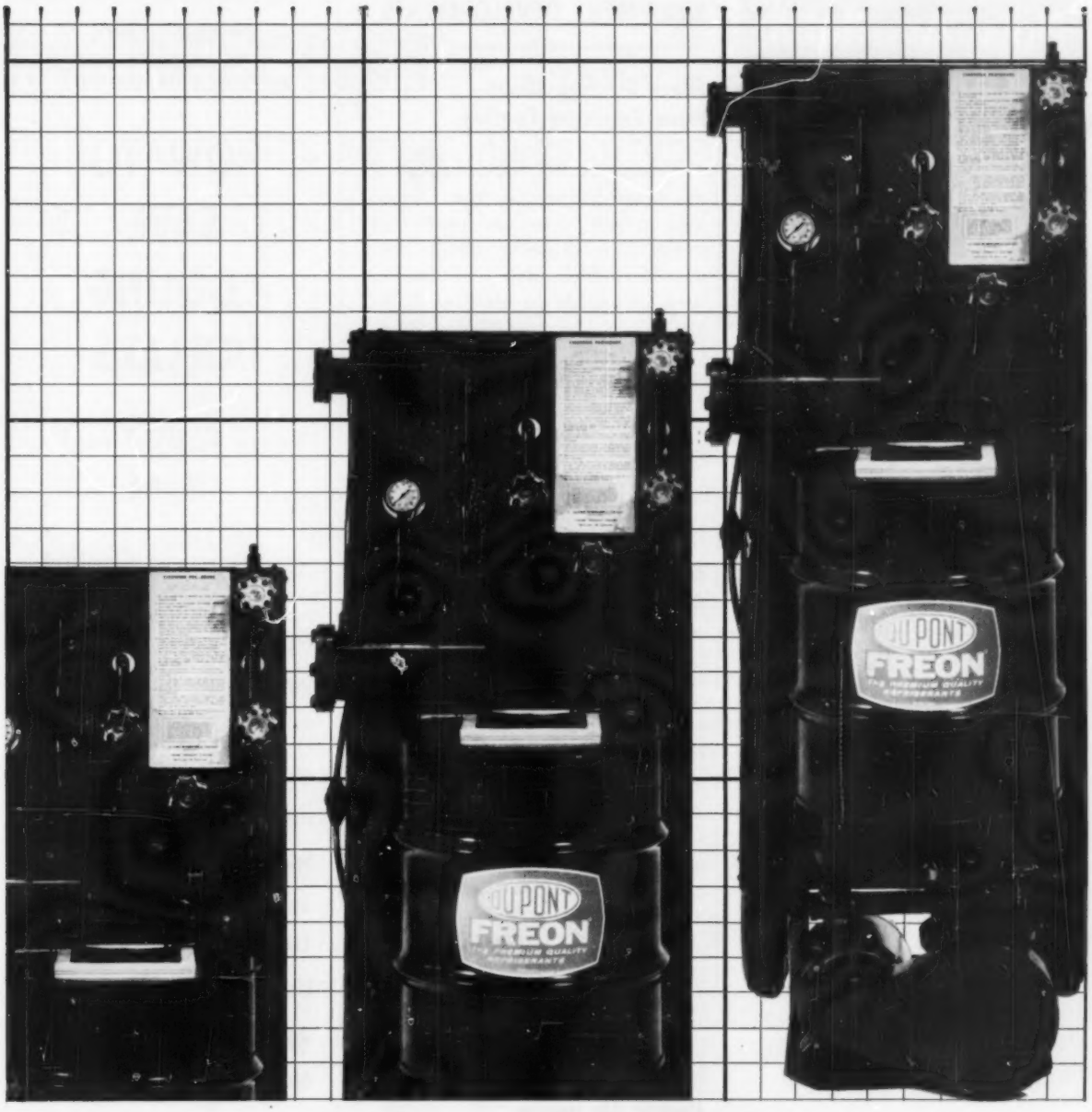
Provide inside-outside protection against corrosion. "Penton" chlorinated polyether is a chemical inert thermoplastic, effective from low temperatures to 250 F and above. Pipe available in standard 10 ft lengths in 1-½ through 24 in. diameters, Schedule 40 wall thickness, clad inside and outside with a 0.025 to 0.035 in. protective coating. Elbows, tees, crosses, reducers, and laterals are available for these sizes. Other wall thicknesses and diameters available on special order. — *The Polymer Corp.*, 2120 *Fairmont Ave., Reading, Pa.*

Gage Sizing Kit For Capillary Tubes

Gages the ID of the following tube sizes: 0.031, 0.036, 0.050, 0.055, 0.064, and 0.070 in. Each gage is permanently identified for size; all are packed in a plastic pouch. — *Madden Brass Products Co., Aurora, Ill.*

Atmospheric Torch Burner Provides 10 to 1 Turndown

Offers wide turndown range with single-valve control. Requires no air blower. Will not flash back on low inputs. Turndown range of low pressure gas is 10 to 1; with gas at 10 psi, 16 to 1. Two series available: capacities from 120,000 to 1,800,000 Btu per hr in the low pressure series; 200,000 to 9,300,000 Btu per hr in the medium pressure series. May be operated against combustion chamber drafts up to 2 in. WG, and with gas pressures from 4 in. WG to 20 psig. — *Pyronics, Inc.*, 17700 *Miles Ave., Cleveland* 2, *Ohio.*



RAISE PROFITS

with this new Du Pont power-cleaning unit for burnouts

You can prevent costly call-backs on refrigeration burnouts—just use this new portable unit designed by Du Pont. It does a fast, thorough first-time cleaning, by complete pressurized recirculation. And it uses Freon-11*, the most effective, selective solvent available for oil and grease.

When you recharge the system, Du Pont's improved light-weight "Zephyr" cylinders make that job a lot easier too. Both the burnout unit and the "Zephyr" can increase your profits and your reputation for good service. Ask your local air conditioning and refrigeration wholesaler who sells "Freon" for details.

*FREON and F- followed by numerals are Du Pont's registered trademarks for its fluorocarbon compounds.
**Patent Applied For

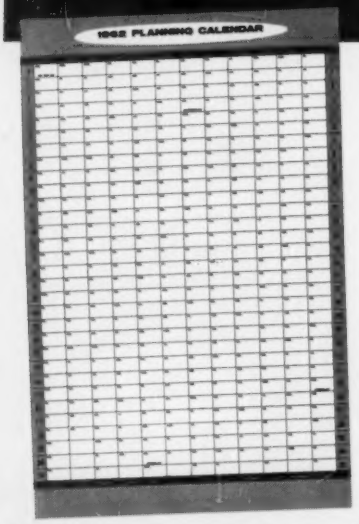
Another help on burnouts is Du Pont's new Acidity Test Paper**. It tells you quickly and surely when the solvent in your hermetic burnout unit has become too acid for use. See your wholesaler for more details.

FREON® *premium quality* ***REFRIGERANTS***

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Now Available
GIANT SIZE!
YEARLY
PLANNING
CALENDAR



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EQUIPMENT DEVELOPMENTS

Continued

Silver Brazing Alloys Have Extrusion Coating

"Trucote #101" features an anhydrous and hygroscopic flux. Can be used on both ferrous and non-ferrous metals. Joins dissimilar metals: copper, brass, high alloy, and stainless steels. Available in sizes of 1/16, 3/32 in. by 18 in. — *All-State Welding Alloys Co., Inc.*, 249-55 *Ferris Ave., White Plains, N.Y.*

Elastomer Diaphragms Are Long-Stroke Type

Available in "Buna N," "Neoprene," "GR-S," "Butyl," "Silicone," "Hypalon," "Polyurethane," "Viton," and "Fluorinated Silicone." Can be used with a wide range of fluids. Low pressure diaphragms without fabric; high pressure type with "Dacron," "Nylon," Teflon," glass, or similar material. — *Diaphragm Industries, Inc.*, 102 *Rantoul St., Beverly, Mass.*

Electric Air Heater Is Explosion Proof

For operation in hazardous atmospheres where gasolines, solvents, gases, fumes, and other flammable substances are present. Tested and approved by Underwriters' Laboratories under Class 1, Group D classification. Features elongated brazed-fin heating element, embedded in compact refractory; a steel framework, housing, and parts; and a baffle which directs the heat flow outward. Unit is wall hung. — *Edwin L. Wiegand Co.*, 7500 *Thomas Blvd., Pittsburgh 8, Pa.*

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Plant Engineers —
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with FANJET roof cooling

10 Degrees Cooling

Combine with air conditioning systems for real benefits. Special division for architects & air conditioning companies.

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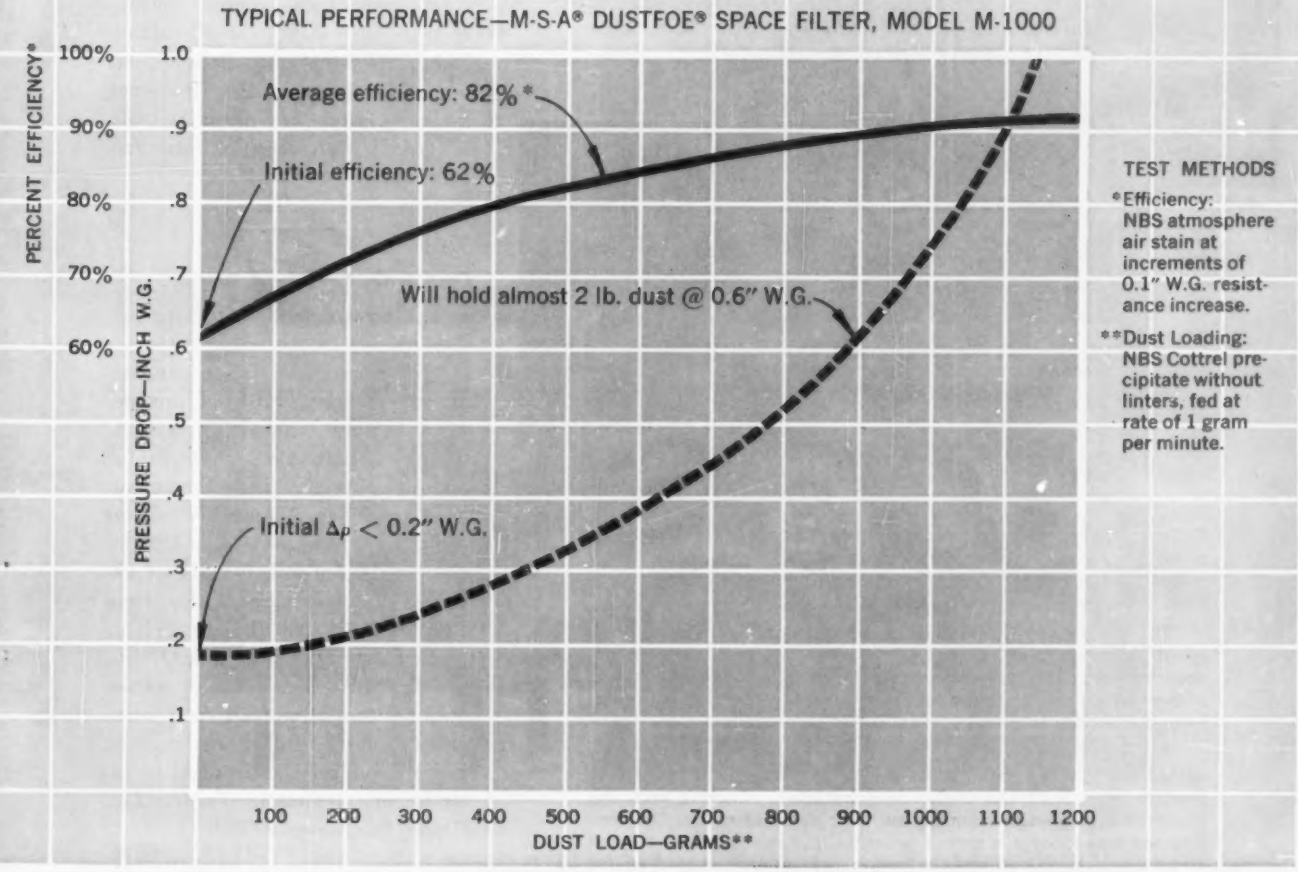
(Mail Coupon for Prompt Reply)

New M-S-A® Dustfoe® Space Filter

lasts six months longer, holds 3 times more dust than previous model



The M-S-A Dustfoe Space Filter is available in either 1000 SCFM models or 2000 SCFM models. Other Dustfoes of higher efficiencies are also available.

Any filter will increase its efficiency with use because of the dust build-up. So how do you get the drop on a really meaningful interpretation of air ventilation filter efficiency? Answer: determine *initial* efficiency.

MSA does. The percentage figures appear in the graph above. And because we have documented our initial efficiency rating, our average percentage figure is just that much more impressive when compared with other filters.

A true high-efficiency filter

A new specially compounded and textured filter medium provides unusually low resistance to air flow. And by presenting an irregular or "fuzzy" surface, this filter permits high initial efficiency, with greater retention of dust in one-half the volume occupied by filters using deep bed media.

UL Approval

On the basis of Flame Exposure tests conducted by Underwriters' Laboratories, these filters will be listed as Class I units.

For a detailed presentation of supporting data on the new M-S-A Dustfoe Space Filter, please write for MSA Technical Products Release-1507. Mine Safety Appliances Company, Pittsburgh 8, Pa.

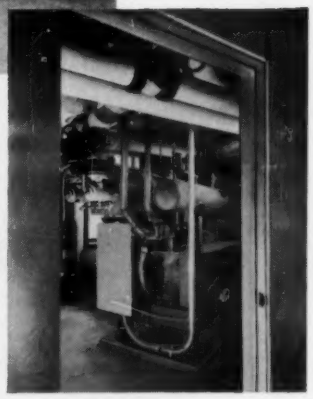
MINE SAFETY APPLIANCES COMPANY
Fluid Purification Specialists

MSA

"Hot" Brain requires Cool Treatment

To process 2,400 checks a minute and provide fast service for its 75,000 checking accounts, the First Wisconsin National Bank of Milwaukee is spending more than $1,500,000 for an automated check handling system second to none.

▲ A view of the First Wisconsin National Bank's new automated check processing system currently geared to handle about 500,000 checks a day. Shown is the computer room. Sorter room is to the left. A third area, the printer room, completes the installation.



This Vilter Uni-Chiller maintains the required temperature with a capacity of 61.8 tons with 55° entering water and 45° leaving water. ▶

● Currently programmed to process the avalanche of 500,000 checks a day . . . 2,400 a minute . . . is the new, fully expandable automated "brain" check handling system built especially for the First Wisconsin National Bank of Milwaukee.

The "hardware" used in this amazing system—computers, high speed magnetic tape machines and printers, multiplex control, document sorters and check encoders—generate substantial amounts of heat which must be rapidly dissipated to protect both the components themselves and the accuracy of the processing.

To help maintain the critical temperature and humidity levels within the glass-enclosed 8,000 square foot area, a Vilter UF-6, flooded type, R-22 Uni-Chiller was installed. Cooling coils are mounted in a plenum chamber with air distributed into the conditioned area through a slotted acoustical tile ceiling. This method of air distribution produces an imperceptible movement of air for maximum comfort of personnel in the room.

You benefit with Vilter refrigeration and air conditioning equipment in two important ways—(1) careful design and precision fabrication result in long life . . . reliable, efficient performance . . . minimum maintenance; (2) a complete and integrated line of equipment, and the experience to counsel you on the best type of installation. Why not let the nearest Vilter representative help you.

System designed and installed by
Thos. E. Hoye Heating Company of Milwaukee

Vilter® refrigeration air conditioning

Vilter Manufacturing Corporation
Milwaukee 7, Wisconsin
Air Units • Ammonia and Freon Compressors • Two-Stage and Booster Compressors • Water and Brine Coolers • Blast Freezers Evaporative and Shell and Tube Condensers • Pipe Coils Valves and Fittings • Pakice and Polarflake Ice Machines Liquid Transfer Systems Air Agitated Ice Builders

Write for helpful bulletins to the Vilter Manufacturing Corporation Dept. F61 2217 South First Street Milwaukee 7, Wisconsin

EQUIPMENT DEVELOPMENTS

Continued

Portable Laboratory Controller Has Multi-Function Application

Unit is basically a portable instrument for the automatic regulation of temperature, but can be applied to the measurement and control of pressure, vacuum, and liquid level. Provides proportional control (modulated duration pulse), on-off control, high limit alarm, as well as an output signal for recorders. Does not cycle. Described in bulletin No. 850. — *Brooks Instrument Co., Inc., Hatfield, Pa.*

Cast Iron Gas-Fired Boiler For Steam or Hot Water Service

AGA approved for natural, mixed, manufactured, and propane gases. Features hundreds of heat absorbing pins on the surfaces of the boiler sections. Net I-B-R output ratings range from 375 to 1690 sq ft of steam and from 90,000 to 405,100 Btu per hr. For either steam or water, AGA output ratings range from 120,000 to 540,000 Btu per hr; for input from 150,000 to 675,000 Btu per hr. Also features large section openings that permit fast water circulation, multiple drilled port burners, and an optional built-in tankless water heater. — *Thatcher Furnace Co., Center St., Garwood, N.J.*

Metal Repair Paste Requires No Mixing

"Lab-Metal" adheres permanently to metal, wood, plaster, glass, or plastic. Serves as a repair material for pipe, tanks, etc. Does not require mixing, heat, or special tools. Withstands heat to 350 F, and when hard can be milled, drilled, tapped, or ground. Can be thinned to paint consistency and applied as a water and rust resistant protective metal coating. — *Alvin Products, Inc., 20-22 Houghton St., Worcester 4, Mass.*

ANOTHER
NEW 3M
CONSTRUCTION
PRODUCT!

ANNOUNCING: a competitively priced, high-performance sealer!

From the maker of duct sealers that safeguard some of the world's largest systems comes new 3M® Brand Duct Sealer Standard Grade. This new companion product of 3M Brand Duct Sealer 800 Premium Grade assures tough, flexible, trouble-free seals . . . meets critical established specification requirements . . . and at a competitive price.

3M Brand Duct Sealer Standard Grade resists both oil and water. Films of ⅛" thickness remain flexible, even over a 1" mandrel at −20°F, and withstand continuous heat exposure as high as 200°F. This sealer may be applied by brush, caulking gun or pressure extruding equipment. Surfaces skin over in 5 to 10 minutes, become tack-free in an hour to avoid collecting dirt. 3M Brand Duct Sealer Standard Grade is recommended for both medium- and high-velocity systems.

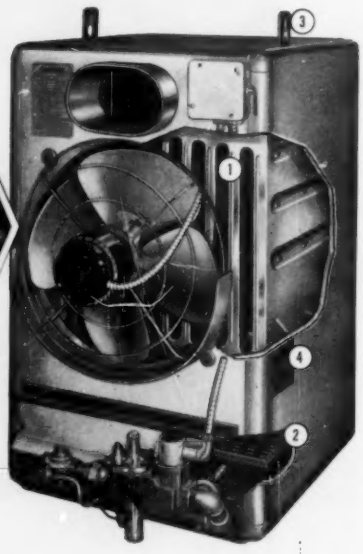
For insulation, there are 3M Brand Adhesives for every bonding need. Included are a formulation that withstands heat up to 300°F, a non-flammable adhesive that eliminates fire hazards during application, and an economical high-coverage formulation for general use. In addition, 3M provides adhesive products for bonding ceramic, clay, vinyl and rubber tile, as well as wood, laminates and other materials . . . for sealing curtain wall, other external joints and surfaces. For data on the complete line of 3M construction adhesives, see Sweet's Catalog, your nearby distributor or write AC&S Division, 3M Company, Dept. SBHX-120, St. Paul 6, Minnesota.

Adhesives, Coatings and Sealers Division 3M COMPANY

Inside story of quality

Mueller Climatrol
DIVISION OF WORTHINGTON

SUSPENDED GAS UNIT HEATER



1. **RESISTAL®** aluminized steel heat exchanger resists corrosion many times longer than ordinary steel. Designed for maximum heat transfer with no direct flame impingement. All-welded construction for quiet operation, long, trouble-free life.
2. Cast-iron drilled-port burners for "clean", service-free operation.
3. Convenient triple-duty lifting and hanging brackets.
4. Automatic fan and limit control plus summer switch.

Complete size range from 25,000 to 225,000 BTU output. AGA and CGA approved for all gases. Shipped assembled, pre-wired, and test-fired.

Write for details today!

MUELLER CLIMATROL
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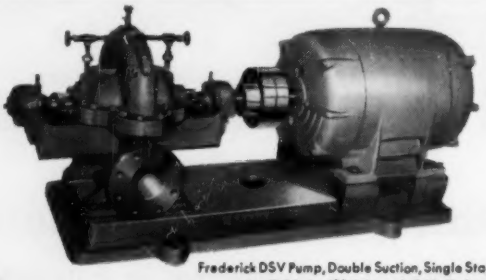
MC-99

FREDERICK CENTRIFUGAL PUMPS

for Air Conditioning, water supply, drainage and fire protection.



Frederick DSV Pump, Double Suction, Single Stage
Available in 1½" through 24" discharge

CUSTOM-BUILT FOR EFFICIENT, DEPENDABLE SERVICE

Whatever your air conditioning or other pump needs, you can choose from a complete line of Frederick Centrifugal Pumps—custom engineered and built for you. Exclusive features assure long service life under the most rugged conditions. In fact, many Frederick Pumps have been in service for over 40 years. Easy to install, easy to operate. Prompt repair service and parts available.

Write for Bulletin 104-A describing mechanical features, giving technical data.

Frederick IRON & STEEL, INC.
FREDERICK Established 1890 MARYLAND

EQUIPMENT DEVELOPMENTS

Continued

Welder/Power Plant Is Gasoline Engine Driven

Powered by a special 15 hp "Onan" air-cooled engine. Welder output is 250 amp (225 amp at 100 percent duty cycle). Also provides 1 kw of d-c while welding, and as a standby power plant, delivers 5 kw of 115/230 v a-c. — *Miller Electric Mfg. Co., Inc.*, 718 *S. Bounds St., Appleton, Wis.*

A-c Motor Starters Are Key and Lever Operated

Provide 1 and 2 pole, across-the-line starting, as well as overload protection, for fractional horsepower motors. The key is to discourage accidental operation and operation by unauthorized personnel. Available in NEMA 1 enclosures or as an open unit. — *Cutler-Hammer, Inc.*, 315 *N. 12th St., Milwaukee* 1, *Wis.*

Portable Electric Infra-Red Heaters Available in Three Types

One model suitable for small areas such as offices and construction shanties; a heavy duty industrial type heater with adjustable tripod stand; and a model with a stand mounted on casters are available. Heaters come in several wattages. — *Insto-Gas Corp.*, 998 *E. Woodbridge Ave., Detroit* 7, *Mich.*

Baseboard Heater Features Three-Position Fan

Has a built-in thermostat, an ozone generating air purifier, and a "fan base" that moves room air mechanically over a heating coil and then forces it out into the room. Fan can be set at fan only, fan with purifier, or off. Available in 4 and 6 ft lengths. — *Air-X Industries, Inc.*, 1210 *Randall Ave., The Bronx, N.Y.*

NOW! Honeywell licks the washing problem in electronic air cleaning

Exclusive Flutter-Jet washing system forces water all the way through to wash away dirt automatically . . . eliminates breakdowns . . . makes a cleaner virtually trouble-free

Efficient washing is the key to efficient air cleaning. But up until recently, nobody was able to come up with a positive, trouble-free washing system.

Now Honeywell engineers have licked this problem once and for all.

Honeywell's exclusive Flutter-Jet washing system does the job thoroughly and automatically. Gone are the problems of breakdown, poor efficiency and high maintenance that have plagued air-cleaning systems in the past.

Removes dirt with a blast of water

A powerful jet-stream of water shoots out of a flexible hose which whips up and down at a rapid rate. This throws thousands of jets of water in, on and through the collection plates. The manifold, moving back and forth, sweeps the area completely, washing every corner.

JETS PENETRATE WHERE SPRAY CAN'T

Mounted on moving manifold, Honeywell Flutter-Jets whip up and down. Blast jets of water all the way through dirty air cleaner plates. Ordinary nozzles tend to fog. Their thin spray fans out. Can't penetrate or clean as jet-streams do.

Honeywell's Flutter-Jet washing system includes five cycles of Jet washing. A final spraying of adhesive can also be supplied when necessary to allow the dirt to be washed off more easily in the next wash.

Unlike other washing systems with spray-type nozzles, Flutter-Jet cannot fog the water or clog, which reduces cleaning power and adds to maintenance.

Already in operation for well over a year in many buildings, the trouble-free operation of Honeywell's electronic air cleaner with Flutter-Jet washing is a matter of record (available just by writing for it).

Before you design the air conditioning for your next building, check into Honeywell's air recovery system, with exclusive Flutter-Jet washing action. Installation is easy, 4 models to choose from to fit every requirement. Service is as close as your client's phone. And, if you want more details, call the nearest Honeywell office—112 throughout the country. Or write Honeywell, Dept. HP-8-154, Minneapolis 8, Minnesota.

HONEYWELL INTERNATIONAL. Sales and service offices in all principal cities of the free world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

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Adjustable

SPROCKET RIM

with Chain Guide

Changes that Danger Zone to a

SAFETY ZONE

—enables you to

ADD PLANT AREA

If re-aligning equipment will yield more working space, better production, lower costs—do it now. Save all space wasted for placing ladders to reach overhead valves. At the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman or contact us direct.

Babbitt

STEAM SPECIALTY CO.

8 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

108-D

EQUIPMENT DEVELOPMENTS

Continued

Flexible Nylon Hose Features Low Refrigerant Effusion Rate

"Nylaflow" hose is a permanently bonded nylon unit consisting of a special polymide innertube with an over-braid of nylon cord and an abrasion resistant external nylon cover. Rated at 400 psi minimum burst strength. Available in inside diameters of 3/16 through ¾ in.; sizes to 1-⅛ in. ID available on special order. Supplied in continuous lengths from 150 to 500 ft or in assemblies with reusable couplings. Operates in temperatures to 225 F and over. Leak test showed a loss of ½ gram per ft of refrigerant 12 in the first seven days of testing with no subsequent losses; tests on refrigerant 22 showed losses of 9 grams per ft. — *The Polymer Corp.*, 2120 *Fairmont Ave., Reading, Pa.*

Two Gas-Fired Heaters for Outside Wall Installation

Recessed sealed combustion "Thru-Vent" units can be installed in any outside wall from 5 to 12 in. thick. Capacities are 23,000 and 31,000 Btu per hr, AGA rated for all gas fuels. Completely weatherproofed on the outside wall, with a vent guard to protect against wind and to prevent burns. — *Commonwealth Co.*, 2127 *W. Commonwealth Ave., Alhambra, Calif.*

Humidifier Evaporates Up To 38 Lb of Water Per Hr

"Aprilaire" humidifier, model "118" is for use with forced air heating. Installed on the plenum or can be mounted on a horizontal duct. Water is evaporated from a water panel (which also has a filtering function) so that moisture is introduced as a vapor. Control is by humidistat. — *Research Products Corp.*, 1015 *E. Washington Ave., Madison* 1, *Wis.*

SAVE TIME— SAVE MONEY

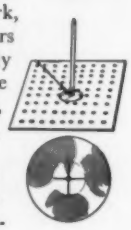
with these dependable INSULATION HANGERS

SEE OUR CATALOG IN SWEET'S OR WRITE FOR COPY

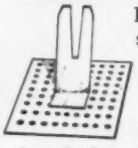
GEMCO

Spindle Hangers and W-A Self-Locking Washers

Ideal for insulation work, Gemco Spindle Hangers are easily and quickly installed... with positive adhesion to concrete, brick or metal. W-A Self-Locking Washers pressed over spindles with minimum effort and lock insulation securely in place.



GEMCO Pronged Hangers



Designed especially for supporting various types of block insulation. Easily applied for positive adhesion. Prongs (available in various lengths from 1 3/16" to 6⅞") bend over to hold insulation firmly in place.

TUFF-WELD Nylon Hangers

Two-piece hangers... with bases of tough, mold nylon and spindles of metal. Made especially for smooth surfaces. Spindles snapped into bases as needed; reduces inventory, storage space, freight costs. W-A Self-locking washers hold insulation securely in place.

TUFF-BOND Quik-Set Adhesive (for smooth or slightly irregular surfaces) and Improved General Purpose Adhesive (for rougher surfaces) assure permanent adhesion of hangers when used as directed. Write or wire for details and specifications.

GOODLOE E. MOORE

INCORPORATED

DANVILLE 28, ILLINOIS

Sunbury Youth and Community Center's new ice rink will provide a five-month continuous skating season despite outside temperature variations. Over 10 miles of SpanGrid Steel Pipe circulate the refrigerant in the rink.

10 miles of SPANGRID Steel Pipe installed in new Sunbury Community Center Ice Rink

Early in 1961, the new ice rink at the Sunbury Youth and Community Center, Sunbury, Pa., opened for skating. The rink area is 85′ x 185′, and over 10 miles of SPANGRID Steel Pipe are used in the refrigeration system. The pipe is covered by a concrete slab so that the rink surface may be used for summer recreational activities.

REPORT FROM THE ARCHITECT

Architect Stan Seiple, Jr., of Sunbury, reports, "Our SPANGRID Pipe order arrived in excellent condition. The pipe ends and interiors were smooth.

"More than 6,000 welds were required during fabrication, and we did not encounter a single problem with the pipe. The whole system passed the hydrostatic test with no leaks. We know it is a fine installation which will give us years of dependable service."

SPANG QUALITY ASSURES DEPENDABLE JOBS

SPANGRID Pipe is ideal for skating rinks, and for radiant heating, snow melting and refrigeration jobs, too. Its uniformity through quality-control manufacturing gives you easy bending, cutting, threading and welding. It's worth trying. Contact your nearby SPANG Pipe Distributor for service.

SPANGRID Steel Pipe is one of the many fine products produced by *National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.*

Steel's Symbol of strength, long life, and economy

Architect: Stan Seiple, Jr., Sunbury, Pa.
Mechanical Contractor:
The Frick Company, Waynesboro, Pa.
General Contractor:
C. F. King, Inc., Sunbury, Pa.
Spang Distributor:
Busser Supply Company, Lewisburg, Pa.
Pipe Supplier:
Sunbury Supply Company, Sunbury, Pa.

ARMCO National Supply Division

EQUIPMENT DEVELOPMENTS

Continued

Unit Heater for Floor Or Overhead Installation

Heated air discharges through adjustable pattern outlets of unit or through existing duct work. Uses gas, oil, or gas-oil. Features ball-bearing mounts for fans, prewired control panels, stainless steel combustion chamber, and heavy gage steel casing. Described in booklet 30X. — *Todd Shipyards Corp., Todd Products Div., Columbia & Halleck Sts., Brooklyn* 31, *N.Y.*

Remote Temperature Controllers Have Single or Double Switches

For use in air or liquid media, both single and dual switch units operate in the same way: pressure on a remote liquid-filled sensing bulb changes with temperature to operate a snap-action switch. Both models available with fixed and adjustable temperature differentials. Features include an external adjustment knob; an integral compensating mechanism for case ambient temperatures; single bulb size for all models; and three temperature ranges: 0 to 100 F, 80 to 180 F, and 160 to 260 F. — *Minneapolis-Honeywell Regulator Co., Commercial Div.,* 2753 *Fourth Ave. South, Minneapolis* 8, *Minn.*

Sheet Metal Box, Pan Brake Has 36 In. Capacity

Available for bench mounting or with a steel cabinet floor stand. Features include: Frame: rigid box construction; finger bar: developed beam section 1 in. clearance between frame and fingers, adjustable for stock thickness; folding bar: deep section and adjustable, reversible for minimum ¼ in. reverse bends, heavy angle, reinforcing bar; bed blade, reversible; back gage: flip-over finger gage for full range 0 to 24 in. with minimum thickness material; capacity: 16 gage mild steel. — *The Peck, Stow and Wilcox Co., Center St., Southington, Conn.*

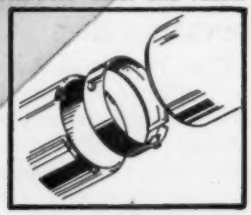
Panel Mounted Gage Has Snap-On Lens

Molded plastic lens permits zero adjustment on the square case unit. Adjustable pointer allows repositionment with a screwdriver. Suitable for handling gases, oils, and other fluids not corrosive to brass or bronze. Measures pressure ranges from 0 to 15 psig minimum through 0 to 3000 psig maximum; and vacuum ranges from 0 to 30 in. Hg. Accuracy is ASME Grade B Commercial (±2 percent of scale over middle half of scale; ±3 percent over the balance of the scale). Described in bulletin F-043. — *American Machine and Metals, Inc.,* 233 *Broadway, New York* 7, *N.Y.*

ROBVON BACKING RINGS

FAST • PRECISE TOLERANCE FIT-UPS

Designed for quick easy alignment of pipe where the variation in inside diameters is relatively great. Chamfered NUBS allow close tolerance fit-up and CLEAN STRIKE OFF. The ROBVON NUB automatically sets root gap. ROBVON rings are beveled to assure non-restricted fluid flow. Available in Carbon Steel, Wrought Iron, Chrome Alloys, Stainless Steel and Aluminum.



Exclusive with Robvon

TYPE "CCC"

ROBVON BACKING RING CO.

Reg. Pat. Nos. 2,764,428 & 2,388,579 675 Garden St., Elizabeth 2, N. J., PH: EL 2-9613

FIGHT TB WITH CHRISTMAS SEALS

ANSWER YOUR CHRISTMAS SEAL LETTER TODAY

RECENT TRADE LITERATURE...

Fallout Shelter Air Control Equipment

Twenty-four page bulletin describes ventilation and air purification for civil defense protective shelters. Applications include shelters of both small and large sizes. Air purifiers remove chemical, biological, and radiological contaminants from the air. Each filter is tested according to AEC specifications which require 99.95 percent efficiency with homogenous smoke of 0.3 micron size. Illustrated with photos, line drawings, graphs, and tables. — *Flanders Filters, Inc., P.O. Box 718, Riverhead, L.I., N.Y.*

Glycol Vaporizer Unit

Four page brochure describes process of sterilization of air by means of introducing 1 cc. of triethylene glycol to each 100,000,000 cc of air (by volume) being handled by a ventilating or air conditioning system. Single unit capacity is 20,000 cfm. Illustrated with photos and line drawings. — *Demuth Development Corp., 501 W. 125th St., New York 27, N.Y.*

Pneumatic Valve Positioner

Two page data sheet gives information on firm's model "J" top-mounted, integral-type positioner which can be used with pneumatic cylinder, springless diaphragm, or spring and diaphragm actuators. Operates on the force-balance principle, and has a two-stage relay. Available in four actions: top or bottom loading, direct or reverse acting. Can be supplied for strokes ¼ to 14 in. and spans from 3 to 24 psi. Contains operation data and specifications. Illustrated with photos, line drawings, and tables. — *Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

Seamless Welding Fittings

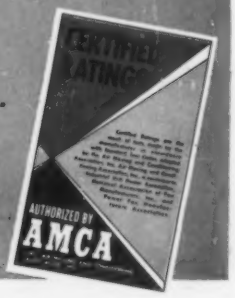
Four page bulletin TF-510 covers 90 deg elbows, long tangent one end or both ends, in standard weight and extra strong. "Long tangent" refers to a short extension of the face tangent to the 90 deg point of the elbow. It provides a straight section on which a slip-on flange can be fitted for welding. Includes charts on all pertinent dimensions in a nominal pipe size range of 1-½ through 12 in. Wall thicknesses agree with ASA B36.10 and dimensional tolerances are as per ASA B16.9. — *The Babcock & Wilcox Co., 161 E. 42nd St., New York, N.Y.*

Type BB Fan

Aladdin
AIR HANDLING EQUIPMENT

For
EFFICIENCY and
QUIET OPERATION...

CERTIFIED
PERFORMANCE



ALADDIN Type BB Fans are the first choice of many engineers for heating, ventilating and air conditioning jobs. Designed for low rotational speeds and high efficiency, these fans insure that stable performance from free delivery to shutoff that engineers have come to expect of this type of equipment.

In designing the BB Fan, Aladdin engineers have refused to short-cut quality, each fan is ruggedly built and is backed by thirty-five years of experience and manufacturing know-how.

Write for complete data

A1

ALADDIN HEATING CORPORATION
1111 WEST AVENUE 137 • SAN LEANDRO, CALIFORNIA

RECENT TRADE LITERATURE

Continued

Small Steel Gate Valve

Two page circular No. 637 describes unit with screwed or socket ends, available in a bolted bonnet design in 1-½ and 2 in. sizes, and in a union bonnet in sizes ¼ through 1 in. Features an inside-screw rising stem, solid-wedge disc, and rolled-in seat rings. Rated at 800 psi at 850 F and 2000 psi at 100 F. A photo is keyed to a table listing nomenclature — *Lunkenheimer Co., P.O. Box* 360, *Annex Station, Cincinnati* 14, *Ohio.*

Gas-Fired Unit Heaters

Eight page bulletin No. A-817 describes series "NF" propeller fan type unit heaters. An exploded view is keyed to a discussion of construction features. Photos are keyed to tabulated dimensional data to permit preparation of installation layout drawings. Includes operating characteristics, application data, and suggested arrangements for layouts. — *American-Standard Industrial Div., Detroit* 32, *Mich.*

Air Cleaning

Eight page booklet B-5214 describes how air handling and air cleaning equipment, featuring "Precipitron" electronic air cleaners, was used in the new Cedar Rapids, Ia. manufacturing plant of Collins Radio Co. Illustrated with photos. — *Westinghouse Electric Corp., Sturtevant Div., Dept. T-576,* 200 *Readville St., Hyde Park, Boston* 36, *Mass.*

High Pressure Fasteners

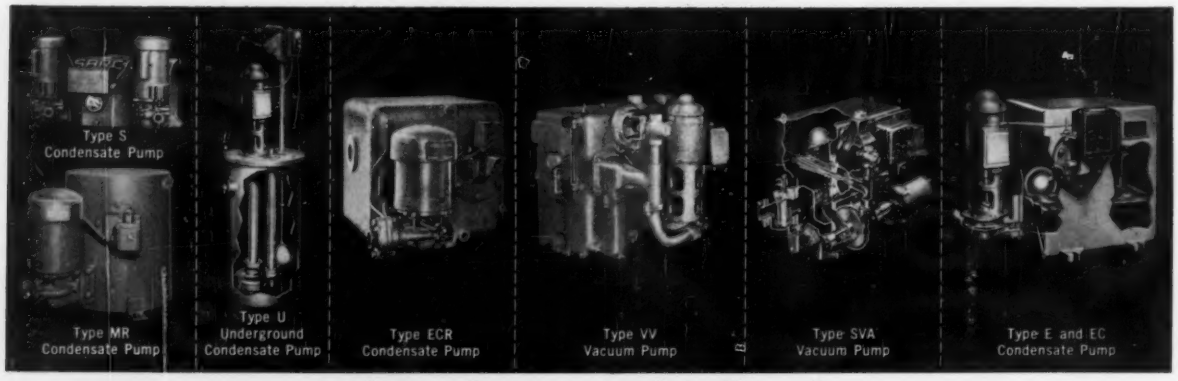
Four page bulletin H61 describes four types of self-sealing fasteners. Three of the units are single-unit fasteners with a groove underneath the head to house an O-ring. The fourth employs the same construction, but has a retaining ring which slips into place on the blind side of the panel. Contains specifications on each type, including temperature range, pressure range, corrosion resistance, sizes, styles, and installation instructions. Illustrated with photos, tables, and line drawings. — *A. P. M. Corp.,* 41 *Honeck St., Englewood, N.J.*

Electrostatic Deodorizers

Series of bulletins outline the commercial and institutional applications of electrostatic deodorizers. — *Morris Deodorizers, Inc.,* 2819 *N. Broadway, Knoxville* 17, *Tenn.*

Pipe Insulation

One page data sheet gives all the physical characteristics of "Hewflex" urethane pipe covering, including density, thermal conductivity, water absorption, maximum temperature limits, and other data. — *United Foam Products Co.,* 2990 *Industrial Blvd., Bethel Park, Pa.*



choose from a complete line of

SARCO CONDENSATE and VACUUM PUMPS

SARCO CONDENSATE PUMPS discharge to boilers fast . . . give quiet, dependable operation . . . are constructed of finest materials . . . engineered for quick, easy installation to meet a variety of conditions . . . have steel or cast iron receivers and close coupled or flexible coupled motors.

SARCO VACUUM PUMPS have a reputation for quality based on a quarter century of experience and development . . . feature jet vacuum-producing unit—highly efficient in producing high vacuums and maintaining full rated water capacities . . . have flexible coupled motors and cast iron receivers.

WHAT ARE YOUR PUMP NEEDS? Make use of Sarco's wide and specialized experience in heating problems involving fluid movements. For information on Sarco condensate and vacuum pumps, all guaranteed for one full year, contact your Sarco sales representative, district office, or distributor; or write:

2362

SARCO

SARCO COMPANY, INC.
AN AFFILIATE OF SARCOTHERM CONTROLS, INC.
635 MADISON AVENUE, NEW YORK 22, N.Y.
PLANT: BETHLEHEM, PA.

RECENT TRADE LITERATURE

Continued

Ball Valve Applications

Four page bulletin No. PB911 describes ball valves designed primarily for critical applications involving high pressures and temperatures, as well as in radio-active environments. Ball in "Ludeman Rotoflo" valve is rotated by an eccentric cam which lifts the ball away from the seat before it is turned to open; permits the use of hard metal seating surfaces. Lists operating and application features, specifications and line drawings. — *General Kinetics Corp.*, 197 *S. Van Brunt St., Englewood, N. J.*

Bearings

Ten page bulletin No. 7104 covers all sizes and styles of "Life-Lube" permanently lubricated, ball-bearing pillow blocks, flange units, and take-up units, as well as porous-bronze and babbitted pillow blocks. Includes a full page of babbitted bearing information on load ratings and maximum shaft speeds. New items in catalog are two-hole flange units, available in shaft sizes of from ½ to 1-7/16 in. Illustrated with photos, tables, and line drawings. — *T. B. Wood's Sons Co.*, 1275 *Fifth Ave., Chambersburg, Pa.*

Glass Fiber Materials

Looseleaf-bound general catalog gives a comprehensive review of corrosion resistance-mechanical properties of resin-bonded glass fiber materials. — *du Verre Inc., P.O. Box* 37, *Arcade, N.Y.*

Lined High Velocity Air Duct

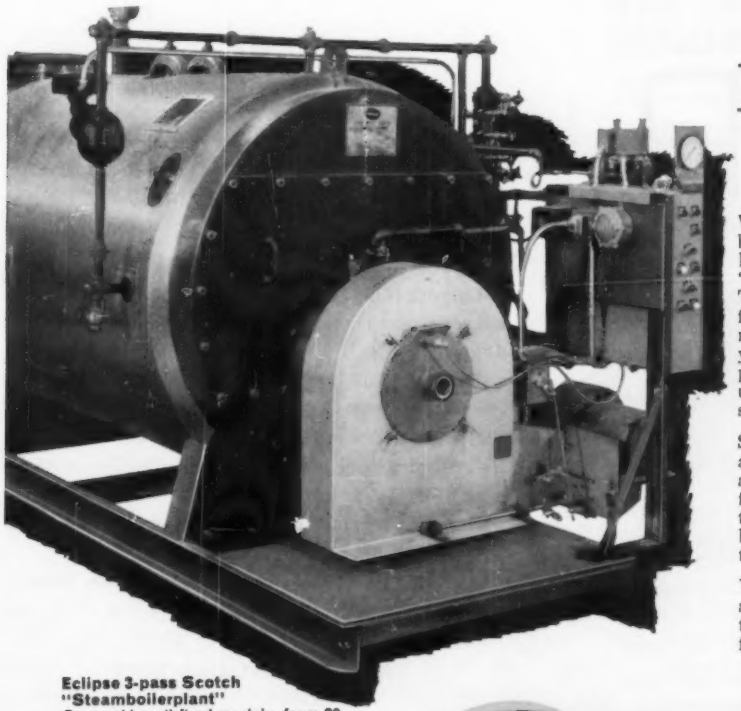
Twelve page bulletin A27 No. 16 covers "Acousti-k27" internally insulated duct and matched fittings in sizes from 3 to 48 in. ID. Engineering design data includes friction loss and acoustical noise reduction performance of straight duct, elbows, and divided flow fittings. Illustrated with photos, tables, and line drawings. — *United Sheet Metal Co., Inc.*, 883 *N. Cassady Ave., Columbus, Ohio.*

Unit Type Dust Collector

Four page bulletin 916 gives data on cloth filter bag dust control equipment. Explains how it is made, how it works, its range of use, and application. Units in seven sizes ranging from 200 to 1000 sq ft of cloth area. Illustrated with photos, line drawings, and tables. — *Pangborn Corp., Hagerstown, Md.*

Air Conditioning

Thirty-two page brochure contains a collection of case history reports. — *Acme Industries, Inc.*, 600 *N. Mechanic St., Jackson, Mich.*



Eclipse 3-pass Scotch "Steamboilerplant"
Gas and/or oil-fired models, from 80 to 200 hp . . . 125 lb working pressure • 2,680,000 to 6,700,000 Btu/hr capacities • fully automatic operation • all boilers certified by a *qualified* insurance company.

125 PSIG

WORKING PRESSURE MINIMUM

Working pressure can tell you a lot about a boiler's ability to meet your steam requirements. For example, *all* Eclipse standard 3-pass Scotch "Steamboilerplants" can operate at 125 psig. This extra pressure margin assures safety with faster heating and plenty of hot, dry steam to maintain the temperature you need . . . even if your boilers run close to capacity for long periods. The basic time-proven Scotch design used in these boilers keeps all heat transfer tubes submerged for highest possible heating efficiency.

Shells are all-welded steel, fully fiberglas insulated. Construction is to A.S.M.E. code standards. Boilers are shipped complete — fully factory assembled, with burner, blower, boiler trim, panel and controls, and complete combustion safeguards — tested, adjusted, ready to install.

Your Eclipse representative can show you why an Eclipse is your best buy in a 3-pass Scotch-type boiler. See him for the facts today or write for our new Catalog No. A-104-3.

Eclipse

ECLIPSE BOILER DIVISION
Manufacturers Rd. & Compress St.
Chattanooga 5, Tennessee

RECENT TRADE LITERATURE

Continued

Industrial Gases

Forty-eight page pocket-size booklet provides data on industrial gases. Lists physical and chemical properties of oxygen, nitrogen, argon, helium, hydrogen, carbon dioxide, acetylene, neon, krypton, xenon, and others. Conversion tables provide a method for changing volumetric information on the various gases from one equivalent unit of measure to another. Illustrated with charts and diagrams. — *Air Reduction Sales Co., Div. of Air Reduction Co., Inc.*, 150 *E. 42nd St., New York* 17, *N.Y.*

Blowers and Gas Pumps

Six page bulletin RAS-261 describes rotary positive displacement blowers and gas pumps. Outlines the advantages of positive volume displacement. Units available in 36 sizes with capacities from 1500 to 30,000 cfm, working pressures to 12 psig, and dry vacuums to 15 in. Hg. Illustrated with photos, line drawings, and tables. — *Roots-Connersville Blower Div., Dresser Industries, Inc.*, 900 *W. Mount St., Connersville, Ind.*

Variable Axial Flow Fans

Twelve page bulletin describes units with adjustable blades. Includes section on applications, design, parallel working of fans, comparisons with other type fans, and cost data. Illustrated with photos, tables, and line drawings. — *Novenco, Inc.*, 40 *Exchange Place, New York* 5, *N.Y.*

Welding Applications

Sixty page application manual gives more than 1000 uses for the firm's specialty alloys for all types of welding, brazing, and soldering of conventional metals. Bronze, copper, stainless steel, cast iron, magnesium, and aluminum joining are covered. Presents specific examples and analysis of costs, time, and operating procedures. Includes 25 illustrations and charts for these examples. — *All-State Welding Alloys Co., Inc., White Plains, N.Y.*

Fly Ash Collecting Equipment

Four page brochure describes gas cleaning equipment for fly ash applications. Discusses application and performance characteristics of electrical precipitators, mechanical collectors, and combination electrical-mechanical collectors. Recent installations are illustrated. — *Research-Cottrell, Inc., Bound Brook, N.J.*

Duct Insulation

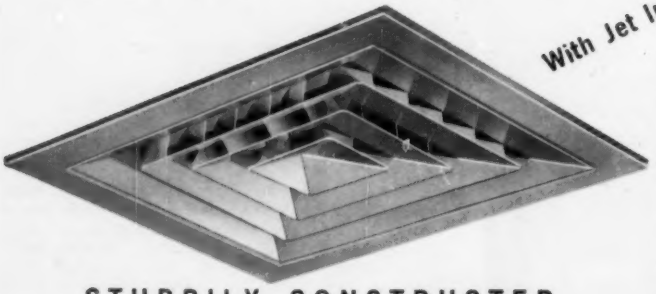
Four page brochure describes five styles of "E-Z Ply" duct insulation: uncoated, "Neoprene" coated, faced with aluminum foil, faced with black asphalt paper, and faced with foil scrim. Illustrated with photos. — *Baldwin-Ehret-Hill, Inc.*, 500 *Breunig Ave., Trenton, N.J.*

THE ORIGINAL SQUARE AND RECTANGULAR AIR DIFFUSERS

AGITAIR®

GENUINE PRODUCTS

With Jet Induction Diffusing Vanes



STURDILY CONSTRUCTED

- All louvers are firmly welded to diffusing vanes in parallel lines.
- The louvers cannot be tampered with or altered.
- Solid construction eliminates strumming or vibration.
- A metal plate is welded at the corner joints to add greater rigidity to the unit.

MORE THAN 1,000,000 IN USE TO-DAY

Only AGITAIR square and rectangular diffusers employ the jet induction feature due to scientically designed diffusing vanes.

These AGITAIR diffusers with built-in diffusing vanes, are designed and positioned to serve as air pumps, compressing the air into a multiplicity of jets. These jets issuing from spaces between adjacent louvers, produce a high degree of turbulence which rapidly mixes the primary and room air and assures control of the entire cubicle contents of the spaces served.

AGITAIR jet induction type diffusers are custom-made with louver arrangements for 1-2-3 or 4 way proportional blows.

Ask for technical catalog R-108

AIR DEVICES INC.

185 MADISON AVENUE, NEW YORK 16, N.Y.

BETTER PRODUCTS FOR

AIR DISTRIBUTION • AIR CLEANING • AIR EXHAUST

RECENT TRADE LITERATURE

Continued

Air Handling

Four engineering reference guides cover air handling problems. "Basic Fan Laws" offers formulas covering volume, pressure, and horsepower. "Air Velocities Required for Conveying Materials" shows the volume and weight of 20 different materials and the velocity and pressure of air required to convey each of these materials. "Velocities Required for Exhaust Hoods" gives the correct number of fpm required for exhausting air through canopy, slotted and portable hoods, and open faced booths in 10 industrial and commercial applications. "Units of Measurement Required for Fan Selection" gives measurement of pressures and vacuums necessary. Each guide is a 5 by 7 in. card. — *Chicago Blower Corp., 9800 Pacific Ave., Franklin Park, Ill.*

Automatic Valve Actuating Conversion Unit

Four page catalog V-200 describes unit that converts hand operated valves to automatic operation. Does not require disturbing piping or replacing valves. Operates electrically. Installs in six steps, requiring about 4 hr labor. Discusses design details and metallurgy. Step by step photos show installation procedures. — *C. H. Wheeler Mfg. Co., 19th and Lehigh Ave., Philadelphia 32, Pa.*

Cooling Water System Pretreatment

Technical data file C4 discusses "Nalprep" pretreatment for preparing and protecting new or cleaned metal surfaces in cooling water systems. Contains a process bulletin which explains when, where, and how to use product. Other data sheets give case histories of the product. — *Nalco Chemical Co., 6216 W. 66th Place, Chicago 38, Ill.*

Boilers and Burners

Fourteen page bulletin No. 6 describes units for commercial and industrial heating. Burners are gas or oil fired. Boilers are two-pass Scotch type. Illustrated with photos. — *Industrial Combustion, Inc., 4447 N. Oakland Ave., Milwaukee 11, Wis.*

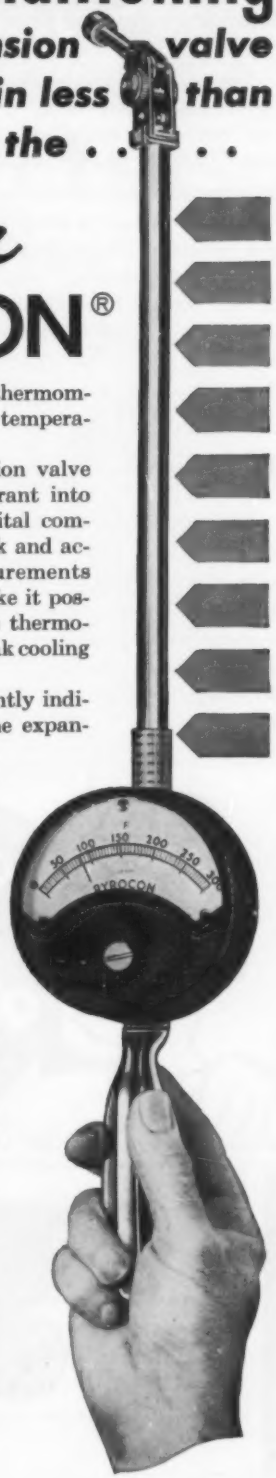
Rotary Air Pumps

Six page bulletin No. 9161 covers three four-vane air pumps providing a range of vacuum to 26 in. Hg., pressure to 13 psig, and volumes from 12 to 54 cfm. Includes performance curves based on horsepower and cfm, plus dimensional data and prices. — *Leiman Brothers, Inc., 102 Christie St., Newark 5, N.J.*

For Air Conditioning

Thermal expansion valve set accurately in less than a minute with the . . .

Alnor PYROCON®



Eliminate the clumsy, slow thermometer method of determining temperatures in the system.

The thermostatic expansion valve controls the flow of refrigerant into the cooling coil and is a vital component of any system. Quick and accurate temperature measurements with the Alnor Pyrocon make it possible to properly adjust the thermostatic expansion valve for peak cooling coil efficiency.

The Alnor Pyrocon instantly indicates the temperature at the expansion valve bulb location. From this temperature, subtract the temperature corresponding to the evaporator pressure. The temperature difference represents the precise superheat and enables the operator to make a perfect setting of the expansion valve immediately.

Pyrocon model 4000 with a temperature range of 0-300° F. is recommended. Price with case including shielded thermocouple tip $125.00 f.o.b. Chicago.

The Pyrocon is also ideal for testing steam traps, balancing hot water systems, locating hot water pipes in cement floors, testing panel heating in walls, floors or ceilings, or making any surface temperature reading.

Other models with ranges up to 0-2000° F. and subzero ranges also available.

Write for Bulletin 4257

Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.
Division of
Illinois Testing Laboratories, Inc.
Room 513, 420 N. La Salle St., Chicago 10, Ill.

RECENT TRADE LITERATURE
Continued

Interlocked Pressure Hose

Six page bulletin No. 15-E describes unit for loading, unloading, and conveying steam, oil, tar, and asphalt. Shows typical assemblies and fittings, listing specifications for mechanically packed-on brass couplings and soldered-on brass couplings. Also recommends handling practices for tar and asphalt hose. Illustrated with photos and tables. — *Atlantic Metal Hose Co., Inc.*, 308 *Dyckman St., New York* 34, *N.Y.*

Oil Preheaters

Eight page brochure VP-61 covers the "Vigilante" oil preheater with tube within a tube construction. Prevents the mixing of oil and water circuits and provides a warning system which detects tube leakage. Illustrated with photos, line drawings, and tables. — *Lindy Hydrothermal Products, Inc.*, 2370 *Hoffman St., New York* 58, *N.Y.*

Building Insulation

Twenty page catalog FB-108 gives data on "Foamglas," a cellular glass insulation, and "Foamglas-Board." Material for use in roofs, curtain walls, core walls, wall linings, ceilings, parking decks, and perimeters. Illustrated with application photos, line drawings, charts, and graphs computing "U" values. — *Pittsburgh Corning Corp., One Gateway Center, Pittsburgh* 22, *Pa.*

Bimetal Thermometers

Sixteen page catalog No. 09-100 covers industrial, laboratory, Navy, and pocket types of bimetal thermometers. Units feature external calibration, in-line scale and pointer, accuracy from ½ to 1 percent, moisture sealing, and removable bezels. Illustrated with photos, tables, and line drawings. — *Weston Instruments Div., Daystrom, Inc.*, 614 *Frelinghuysen Ave., Newark* 14, *N.J.*

Control Valves

Eight page booklet compares control valve construction, operation, and cost. Discusses such subjects as shut-off, maintenance, difference in body construction, and an actual price comparison between the two types of control valve design. — *Conoflow Corp.*, 2100 *Arch St., Philadelphia* 3, *Pa.*

Diamond Core Bit Drilling

Brochure includes such subjects as what to look for in a drilling machine, equipment operation, maintenance, and drilling technique. Describes three types of diamond bits: surface set resettable; surface set throw-away; and impregnated. — *Clipper Mfg. Co.*, 2800 *Warwick, Kansas City* 8, *Mo.*

CHECK THESE FEATURES

- ✓ Stops pulsating and chattering
- ✓ Increases heating efficiency and ouptut
- ✓ One unit handles furnace or boiler, incinerator and hot water heater on single chimney
- ✓ Keeps furnaces, boilers and chimneys free of soot
- ✓ Stops blow-back of poisonous fumes
- ✓ Ideal for homes with outside chimneys
- ✓ Fireplace units with special fittings for direct installation into chimneys with single or two-speed motors available

Will operate with temperatures up to 1700 degrees

A COMPLETE LINE OF RESIDENTIAL AND LIGHT CONSTRUCTION MODELS

20176-QD

WRITE FOR NEW LOW PRICES ON ALL THESE MODELS

HEAVY-DUTY INDUSTRIAL UNITS AVAILABLE
12" 14" 16" 18" 20" 22" 24" 30"
Larger sizes can be made to order

For corrosive service all Quickdraft units are available in standard acid-resisting vitreous enamel, 316 stainless steel, rigid plastics (P.V.C) and with plastic or Fiberglas coatings.

Quickdraft CORPORATION
P.O. Box 1353-K
Sta-C, Canton, Ohio

WE HEAR THAT . . .

BELL & GOSSETT CO. has acquired the *REZNOR MFG. CO.* on an exchange of stock basis. Reznor will be operated as a wholly owned subsidiary of Bell & Gossett, with no proposed changes in management.

Four firms in the heating equipment field, all based in Philadelphia, Pa., have merged to form the *REPCO PRODUCTS CORP.*, an integrated manufacturer of a complete line of heating equipment. The companies involved were All American Products Co., Republic Products Co., General Heating Products Co., and W. H. Bunten Co. The firm's home base is in Philadelphia; sales offices are located throughout the country.

BOHN ALUMINUM & BRASS CORP. is expanding the plant of its Danville (Ill.) Div. The new facilities will give the plant additional space for dockage and warehousing of raw products, and will raise the total plant area of this division to 181,000 sq ft. Completion of the project is expected by the end of this year.

Charles J. Allen, associate in the firm of *ALBERT KAHN ASSOCIATED ARCHITECTS AND ENGINEERS, INC.*, has been appointed assistant chief mechanical engineer. Mr. Allen is a registered professional engineer in both mechanical and chemical engineering. He also holds a certificate from the National Board of Engineering Registration.

Frederick S. Burroughs was named vice president of the *NATIONAL OIL FUEL INSTITUTE* by action of the Board of Directors at the annual meeting of NOFI held recently in New York.

ANACONDA AMERICAN BRASS CO. has opened a new research and technical center in Waterbury, Conn. The center contains 50,000 sq ft of space, has approximately 100 employees, and was built at a cost of $1,500,000.

MINE SAFETY APPLIANCES CO. has organized a *CIVILIAN PROTECTION DIV.* to market air filtering and oxygen producing equipment for fallout and bomb shelters.

RICHARDS INDUSTRIES, INC. has acquired Dover Corp.'s OPW-Jordan Div. The new name of the division will be the *JORDAN VALVE DIV.*

HANDY & HARMAN has moved its New York plant to 525 Nuber Ave., Mount Vernon, N.Y. The firm's Providence, R.I. plant has been moved to a new location at 845 Waterman Ave., East Providence, R.I.

VORTOX

AIR FILTERS

DUST and GREASE

Vortox permanent Filters use genuine coil spring media. Channel formed frames are of heavy gauge steel. Simple and easy to clean.

1. Top efficiency
2. Low restriction
3. High dust capacity
4. High airflow capacity
5. Sturdiness and long life.

Exclusive representation available in some Midwest territories.

Specify VORTOX Air Filters — Engineered and Built for a Lifetime

VORTOX COMPANY

CLAREMONT, CALIFORNIA
(LOS ANGELES AREA)

ELECTRIC
HOT WATER HEAT
TO 2,500,000 B.T.U.
OUTPUT

PRECISION
ELECTRIC HOT WATER HEATING BOILER

COMPLETE UNIT READY FOR INSTALLATION
with circulation hot water system and water chiller for year-round air conditioning.

CONVERSION EASILY ACCOMPLISHED
where other type fuels now used. Suited for home, churches, motels, apartments, hotels, hospitals, commercial buildings, swimming pools, snow melting and domestic hot water for large users. Temperature range — 60 to 250 degrees. Equipped with Sequence and Proportional Controls when desired.

- Every unit tested and inspected 40,948 to 2,500,000 B.T.U. Output.
- All Boilers meet the requirements of the ASME Boiler and Pressure Vessel Code. Natl. Board approved.

No chimney! No odors! No flame! No ducts! No noise!

Write for complete specifications and prices

PRECISION parts corporation
400-HPA NORTH FIRST STREET
NASHVILLE 7, TENNESSEE

WE HEAR THAT

Continued

A 55,000 sq ft addition is being built for *WESTINGHOUSE ELECTRIC CO's* air conditioning division at Staunton, Va. Part of a $2 million expansion program, the project is due for completion in the second quarter of 1962.

Charles W. Lockhart has been elected president of the *AIR MOVING AND CONDITIONING ASSOCIATION, INC.* Mr. Lockhart is vice president in charge of sales for Buffalo Forge Co. Other officers elected are: vice president L. A. Macrow, chief engineer, Carrier Air Conditioning Co., Div. of Carrier Corp.; vice president R. C. Niess, manager of product sales, York Div., Borg-Warner Corp.; and secretary-treasurer John F. Tobin, vice president of marketing, American-Standard Industrial Div.

THE CHICAGO ASSOCIATION OF CONSULTING ENGINEERS recently held a seminar for building codes in Chicago, Ill. Seventy men attended the seminar, 21 of whom were representatives of the association.

SARCO MFG. CORP. has begun construction of a new multi-million dollar factory in Allentown, Pa. Total initial floor space will be 113,400 sq ft, planned to accommodate 500 employees. The single level building located on a 22 acre site will house manufacturing, warehouse, office, and cafeteria under one roof. A completion date of June 1962 has been set.

JAMAICA MFG. CO., INC. has acquired the former Queen City Valve Mfg. Co., of Covington, Ky. The acquired company will be known as *JAMAICA VALVE MFG. CO.*

BYRON JACKSON PUMPS, INC. has increased the test motor capacity of its hydraulic test laboratory facilities to a total of 17,500 hp. The facility is used for determining hydraulic performance characteristics of new centrifugal pump designs. With the new additions, the total floor area is 9180 sq ft, with a 400,000 gal underground reservoir.

A pair of newly developed temperature measuring devices will be put on the market soon under agreement signed recently by the *BOEING CO.* and *RdF CORP.* The agreement involves two Boeing-developed instruments. One is a temperature gradient compensated device which measures temperatures from a distance. The other is a thermal parameter indicator for measurement of all the physical parameters associated with flow to and from a surface. RdF will manufacture and sell both instruments in the United States under an exclusive license from Boeing Associated Products, an agency of Boeing.

MEETINGS & CONVENTIONS

1962

JAN. 22-25 — *Plant Engineering and Maintenance Conference and Show.* Convention Hall, Philadelphia, Pa. Information: Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

JAN. 28-*FEB.* 1 — *American Society of Heating, Refrigerating and Air-Conditioning Engineers Semi-Annual Meeting.* Chase-Park Plaza Hotel, St. Louis, Mo. Information: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 345 E. 47th St., New York 17, N.Y.

FEB. 12-15 — *Air Conditioning and Refrigeration Industry* 12*th Exposition.* Great Western Exhibit Center, Los Angeles, Calif. Information: George E. Mills, Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

MARCH 19-21 — *Second National Electric Comfort Heating Exposition, National Electrical Manufacturers Association.* Sherman Hotel, Chicago, Ill. Information: National Electrical Manufacturers Association. 155 E. 44th St., New York 17, N.Y.

MARCH 19-22 — *Fourth Annual Industrial Ventilation Conference, North Carolina State College.* School campus, Raleigh, N.C. Information: Motte V. Griffith, Jr., PIO, College Extension Div., North Carolina State College of Agriculture and Engineering, P. O. Box 5125, Raleigh, N.C.

MARCH 19-23 — *National Association of Corrosion Engineers Annual Conference and* 1962 *Corrosion Show.* Kansas City Auditorium and Muehlebach Hotel, Kansas City, Mo. Information: National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Tex.

MILLER ELECTRIC MANUFACTURING COMPANY
APPLETON, WISCONSIN

YOU GET MORE
WITH A MILLER

The practical limits of perfection in d-c welding, as such limitations are assessed today, are attained in Miller Gold Star welders with their exclusive, completely sealed, semi-metallic rectifiers.

Top illustration — the SR — comes in four basic models of from 200 to 600 amperes, with duplex hook-ups rated to 1200 amperes.

The space-saving SRH is only 30¼" high and is used widely for stacking and paralleling where room is at a premium. This model is offered in 200, 300 and 400 amperes.

Complete particulars on the above welders will be sent promptly upon request. Also available is a frank and interesting pamphlet titled "Rectifiers for Welding," which gives a question and answer treatment to the established facts of welder rectifiers.

•

Distributed in Canada by
Canadian Liquid Air Co., Ltd., Montreal

MEETINGS & CONVENTIONS

Continued

APRIL 9-12 — *24th National Oil Heat and Air Conditioning Exposition.* Chicago, Ill. Information: National Oil Fuel Institute, Inc. 60 E. 42nd St., New York 17, N.Y.

APRIL 9-13 — *43rd American Welding Society Annual Meeting and Welding Show.* Sheraton Cleveland Hotel and Cleveland Public Auditorium, Cleveland, Ohio. Information: American Welding Society, 345 E. 47th St., New York 17, N.Y.

APRIL 30-*MAY* 1-2 — *54th Annual Convention of the Southern Gas Association, combined with the American Gas Association Spring Transmission Conference.* Houston, Tex. Information: Southern Gas Association, Inc., 1524 Life Building, Dallas 2, Tex.

APRIL 25-29 — *Western Space Age Industries and Engineering Exposition.* Cow Palace, San Francisco, Calif. Information: Lykke-Wilkin & Associates, 681 Market St., San Francisco 5, Calif.

MAY 8-11 — *Mechanical Contractors Association of America 73rd Annual Meeting.* Sheraton Hotel, Philadelphia, Pa. Information: Mechanical Contractors Association of America, Inc., 45 Rockefeller Plaza, New York 20, N.Y.

JUNE 4-7 — *Annual Meeting of the Institute of Boiler and Radiator Manufacturers,* Seaview Country Club, Absecon, N.J. Information: Institute of Boiler and Radiator Manufacturers, Room 408, 608 Fifth Ave., New York 20, N.Y.

JUNE 18-20 — *American Society of Heating, Refrigerating and Air-Conditioning Engineers Annual Meeting.* Deauville Hotel, Miami Beach, Fla. Information: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 345 E. 47th St., New York 17, N.Y.

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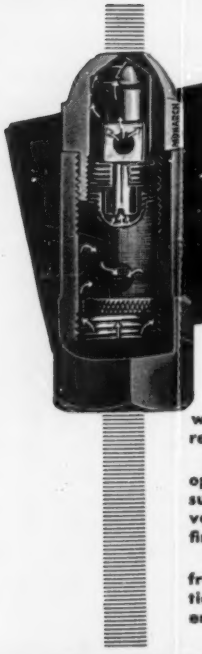

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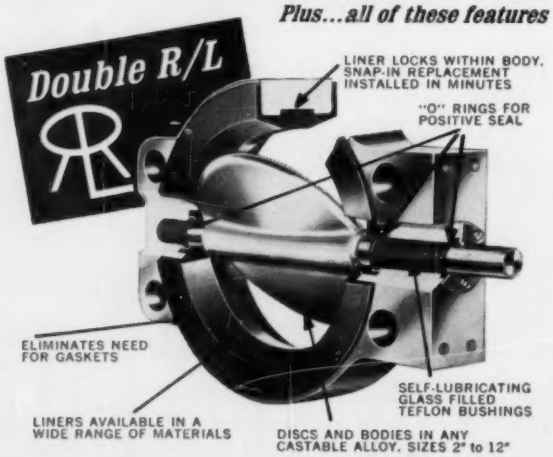
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Possible Requirements for Radioisotopes as Power Sources TID-12711 — The purpose of this report is to give the current status of possible large-scale uses of separated fission products and certain alpha-emitting isotopes in quantities which exceed present availability and market. It discusses applications, evaluations on the basis of technical feasibility, economics, competition, radiological-safety aspects, and specific radioisotopes. The report was prepared by Dr. William H. McVey of the Atomic Energy Commission's Office of Operations Analysis and Forecasting. Price, 50 cents. — *U.S. Atomic Energy Commission, Washington* 25, *D.C.*

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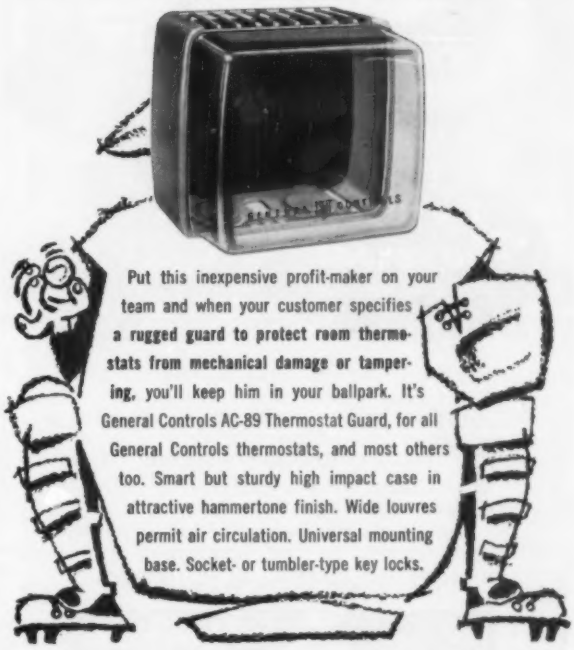

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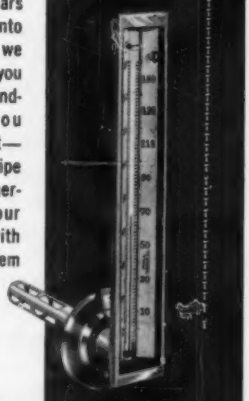

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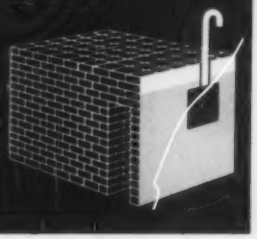

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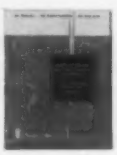

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Report on Physical Properties of Metals and Alloys from Cryogenic to Elevated Temperatures — Physical-property data of six metals and their alloy systems—aluminum, cobalt, iron, magnesium, molybdenum, and nickel—comprise the text of this new publication prepared by the Battelle Memorial Institute, under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee of Effect of Temperature on the Properties of Metals. Data on physical properties included in this publication are thermal conductivity, linear thermal expansion, specific heat, electrical resistivity, density, emissivity, diffusivity, and magnetic permeability. Emphasis is given to data over a range from cryogenic (−457 F) to elevated (4500 F) temperatures. Price, $4.75. — *American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.*

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1960 *ASTM Proceedings, Volume 60* — This 1242 page volume is the official record of the proceedings of the American Society for Testing and Materials for the year 1960. It records the technical accomplishments, including reports and papers, together with discussions. The summary of proceedings of the ASTM 63rd Annual Meeting, held in June 1960, and the annual report of the board of directors are also published in this volume. Price, $12.00 — *American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.*

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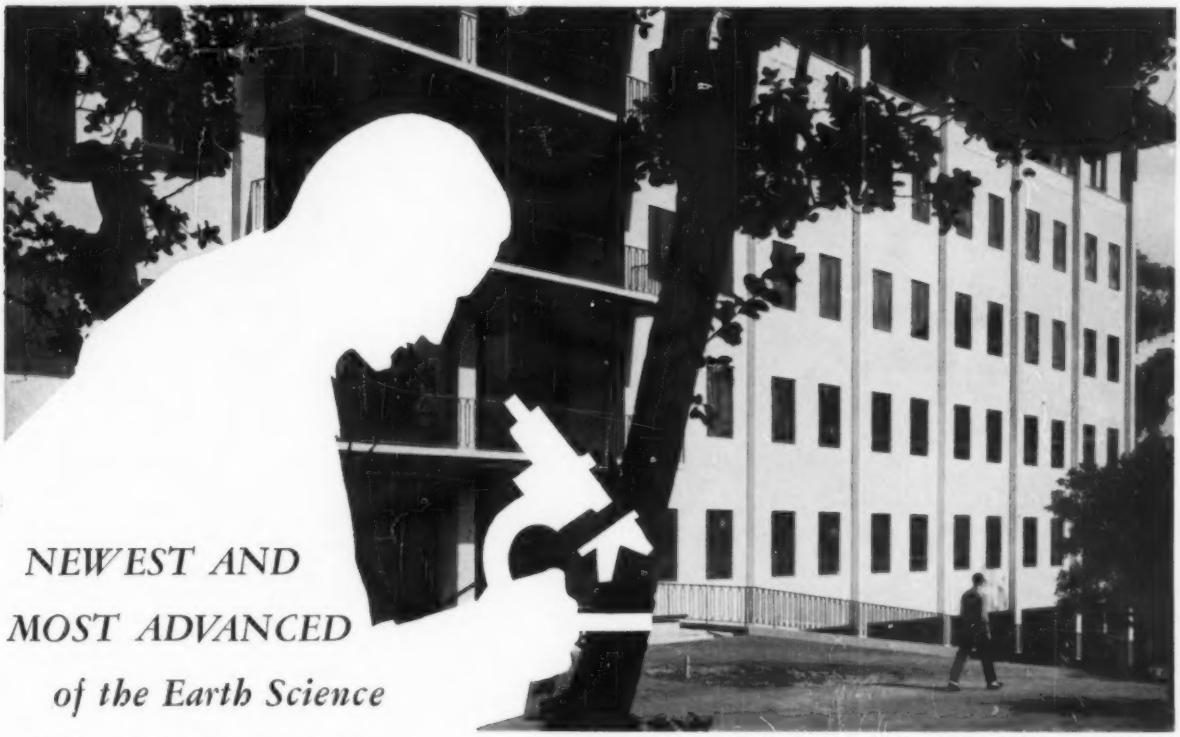

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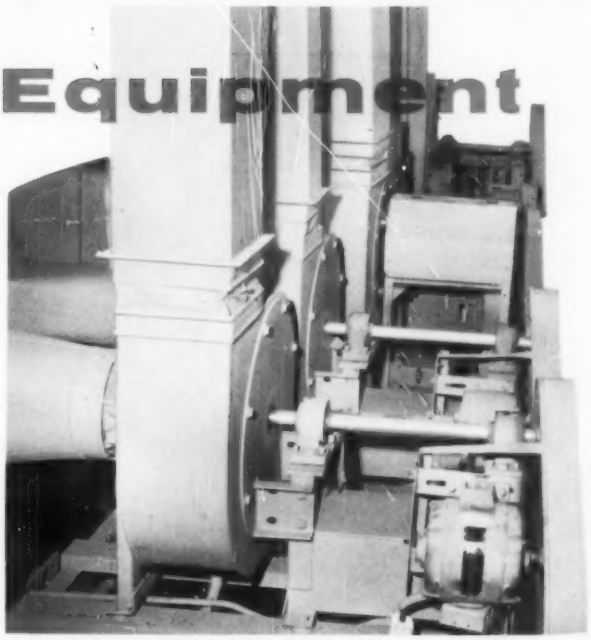

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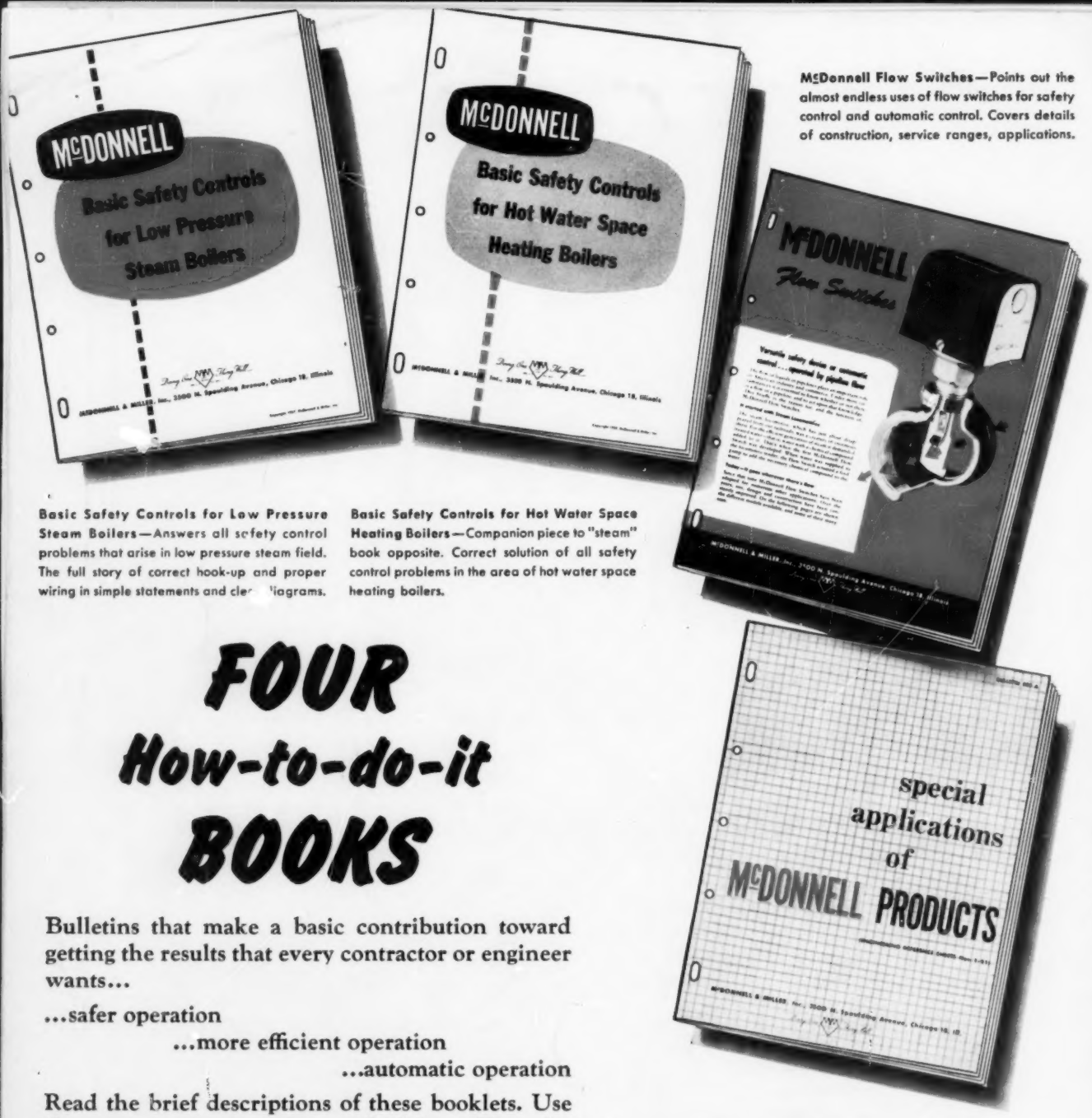

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